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THIRD ANNUAL REPORT

OF THE

Commissioners of Inland Fisheries

OF

RHODE ISLAND.

PRESENTED FEBRUARY, 1873.

NOV 21 1923

State of Rhode Island, &c.

THIRD ANNUAL REPORT

OF THE

Commissioners of Inland Fisheries,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, A. D. 1873.

PROVIDENCE:
PROVIDENCE PRESS COMPANY, PRINTERS TO THE STATE.
1873.

REPORT.

To the Honorable General Assembly:

The Commissioners of Inland Fisheries beg leave respectfully to present their third annual report.

STATE HATCHING ESTABLISHMENT.

It is with much pleasure that the Commissioners are able to report that the hatching establishment at Ponaganset has met with good success. Of the 30,000 trout spawn bought last year, about 90 per cent. were hatched, but owing to the extreme heat of last summer, 10 per cent. more of the young fish were lost, making a total of 80 per cent. hatched, or about 24,000 trout. The ponds in which the young fish were placed were not properly constructed, they requiring at least four feet of water and steep banks with considerable shade. The young fish require a temperature below 72° Fahrenheit, above which point the fish die in large numbers.

Of the number hatched, about 19,000 were placed in the Pawtuxet river. A part of this number having been carried into it by a freshet, the Commissioners felt compelled to place so large a number in this river as the ponds were not suitable for the fish. The Pawtuxet river was chosen, partly because it was but a few steps from the hatching establishment, and partly because of the numerous small tributaries which are known to have been in former years full of trout, but at present perfectly depleted. The Commissioners have on hand in ponds constructed for the purpose, about 5,000 young fish. Out of this number they propose to retain some for breeding purposes and some for stocking different streams.

SALMON.

Of the 10,000 salmon spawn purchased last year, about 50 per cent. were found not to be impregnated. On informing Mr. Samuel Wilmot, who furnished the spawn, of this fact, he at once forwarded another 5,000 of perfect spawn, free of cost. Of the total number, nearly all hatched, the loss being less than 1 per cent. It was observed after the young fish were hatched and the umbilical sack absorbed, that they would not take artificial food as readily as the trout. Fearing that a majority would be lost, the Commissioners decided to place the greater number of the young fish in the Pawtuxet river, and retain only a small portion of them in ponds constructed for the purpose.

The Commissioners attended a number of meetings of the Fish Commissioners of the New England States, and also a meeting called by Hon. Spencer F. Baird, United States Commissioner of Fish and Fisheries. At one of these meetings Mr. Charles G. Atkins, former Commissioner of Maine, suggested that the different New England States should combine together and through him procure salmon spawn. This proposition was agreed to by the Commissioner of Fish and Fisheries of the United States, Commissioners of Fisheries of Connecticut, Commissioners of Inland Fisheries of Massachusetts, Commissioners of Fisheries of Maine, Commissioners of Inland Fisheries of Rhode Island, and Mr. William Clift, of Connecticut. The number of spawn to be divided in the same ratio as the amount subscribed. The State of Rhode Island subscribed $400.

Mr. Atkins has been very successful in procuring the salmon spawn, the share for the State of Rhode Island being from ninety to one hundred thousand. This brings the cost to about $5 per thousand, a marked saving from what was paid last year, being $35 gold per thousand. These spawn are expected daily, when they will at once be placed in the hatching boxes. The young fish, when hatched, will be placed in the Blackstone, Pawtuxet and Pawcatuck rivers. The object of the meeting called by Hon.

Spencer F. Baird, was to discuss the distribution of the salmon ova presented by the Prussian government to the United States, and also the distribution of salmon ova procured in Maine. The Commissioners regret to report that the salmon spawn from Europe will be nearly if not a total loss, caused by unusual delays and unusual warm weather they were exposed to before being shipped. But the Hon. Spencer F. Baird has kindly informed your Commissioners that 10,000 salmon spawn were awaiting their orders in Maine.

SHAD.

The Commissioners decided to try the experiment of placing some shad in the three largest rivers in this State, viz.: the Blackstone, Pawtuxet and Pawcatuck. They wrote to the Fish Commissioners of Massachusetts and requested a permit to procure shad spawn at Hadley Falls, and were requested to apply to the Fish Commissioners of Connecticut, who were at that time procuring large numbers of spawn at Hadley Falls. On applying to Mr. William M. Hudson, he very kindly offered us all we wanted of young fish, free of cost, excepting a small sum paid to Mr. Smith, who had charge of the hatching boxes. Not a single fish was lost in the transportation, which was wholly due to the good care given them by Mr. Robert Holmes, who had charge of the fish, and the facilities extended by the Providence & Worcester and Providence and Stonington railroads in permitting the transportation of these fish in their express trains. The success in not losing a single fish would have been very doubtful without these facilities, as a large number of the fish were necessarily confined in a small compass.

BLACK BASS.

But a small number of these valuable fish were placed in ponds of this State during the past year, owing to a large number having been stolen from the parties your Commissioners engaged the fish of. Little time will be lost, as most of the ponds were intended to be stocked in the fall. These fish would not have spawned until May or June of this year. More fish have been engaged, and they will be placed in the ponds in March and April. The following ponds were stocked last year by the Commissioners:—Beach Pond, Newport, 41 black bass; Stafford Pond, Tiverton, 41 black bass. Prince's Pond, Barrington, was stocked by private parties.

In view of saving traveling expenses, your Commissioners decided to send printed notifications to the different town councils of towns in the State, representing that the Commissioners were prepared to stock suitable ponds in their several towns with black bass, provided the town councils would pass the required laws for their protection. The following towns have responded to these notices:—Hopkinton, Yawgoog Pond; Warwick, Phonoganset Pond; North Kingstown, Carr or Belleville Pond; West Greenwich, Miswick Pond; South Kingstown, Yawkers and Harkins Ponds; Exeter, Deep Pond.

It has been the custom to stock ponds with one and two years old fish. The Commissioners propose this year to change this by placing large mature fish of from three to five pounds, being from three to five years old. The advantages of this plan are as follows:

First, the fish being placed early in the spring, will spawn the same year. Second, the fish being large, can fully protect themselves against the pickerel; and lastly, as the fish would spawn the first and every succeeding year during the three years of close time, the first young fish hatched would be of sufficient size to be marketable, and also old enough to deposit spawn.

The Commissioners have recommended certain additions to the existing laws, regulating Inland Fisheries, and they most sincerely hope that your honorable body will consider the matter favorably.

FISH WAYS.

The Commissioners had fully intended last year to construct a model fish way over the Pawtuxet dam at Pawtuxet, and consulted with Mr. Bracket, Commissioner of Massachusetts, who very kindly sent drawings and working plans of what was then considered the most successful fish ladder in use. The dam was examined, and the contract for building the fish way about to be closed, when at a meeting of the Fish Commissioners of different States, Mr. Bracket doubted if a fish ladder constructed on that plan would work, but expressed more confidence in a new fish ladder, then just completed. Your Commissioners at once concluded to wait for the results of the newly constructed ladder. In the last report of the Massachusetts Commissioners, this ladder is highly recommended, and the Commissioners hope with the consent of Mr. Bracket, to construct a like fish ladder over the Pawtuxet dam this spring.

In 1872 the city of Providence appropriated $500 for the construction of a fish ladder over the same dam; but this sum would not be sufficient to cover the cost of building a suitable fish way for shad and salmon, and taking into consideration that this first fish ladder, when properly constructed and proved to be a success, would, as a pattern to go by, be a benefit to the whole State, the Commissioners would most respectfully recommend your honorable body to appropriate an additional $500 to be expended solely for the purpose of constructing this particular ladder over the Pawtuxet dam, under the condition that only so much of the $500 appropriated should be be drawn from the State treasury as would be required over and above the appropriation already made by the city of Providence.

FINANCES.

State of Rhode Island in account with the Commissioners of Inland Fisheries.

Dr.

Labor on Hatching Establishment,	$268 35	
Lumber,	24 84	
Coal,	18 22	
Sundries,	5 62	
		$317 03
Robert R. Holmes, travelling expenses,	27 46	
Commissioners, travelling expenses,	96 07	
		123 53
Robert R. Holmes, travelling expenses in procuring shad and putting same in three rivers,		99 90
One year's rent of land,	10 00	
C. G. Atkins, salmon spawn,	400 00	
Travelling expenses for salmon spawn,	25 00	
Extra expenses for salmon spawn,	7 00	
Robert R. Holmes, 82 black bass and expenses,	103 40	

	Pike & Atwood, (services as police officers,)	18 00	
	Printing,	5 50	
			568 90
			1,109 36
	Balance on hand with Commissioners,	167 60	
	"	1,062 50	
			1,260 10
			$2,369 46

CR.

1873. February 24.	By amount of appropriation for 1872,	$1.500 00	
	" balance on hand for year 1871,	869 46	
			$2,369 46
1873. February 24.	By balance brought forward,		$1,260 10

This statement shows that the Commissioners have $1,260.10 on hand, over and above the expenses of the year 1872, and they would respectfully recommend that the sum of fifteen hundred dollars ($1,500) be appropriated to meet the expenses of the year 1873.

JOHN H. BARDEN,
NEWTON DEXTER, } *Commissioners.*
ALFRED A. REED, JR.,

Providence, Feb. 24, 1873.

APPENDIX.

[From the General Statutes of the State of Rhode Island.]

TITLE XVIII.

CHAPTER 137.

OF THE INLAND FISHERIES.

SECTION
1. Commissioners of inland fisheries, how appointed, and term of office.
2. Duties of commissioners.
3. Of publication, &c., of their regulations.
4. Penalty for violating regulations made by the commissioners, or taking fish, &c., from ponds, &c., stocked for cultivation of fish.
5. Penalty for catching fish within half a mile of the outlet of a fishery set apart as aforesaid.

SECTION
6. Commissioners may remove obstruction to migration or culture of fish.
7. Fish not to be taken from stocked fisheries for three years after establishment thereof.
8. Disposition of penalties recovered for violations of this chapter.
9. Commissioners may take fish from fisheries for certain purposes.
10. May pass over private property in discharge of their duties.
11. Shall be allowed their actual disbursements.

SECTION 1. The governor shall appoint three commissioners, to be known as the commissioners of inland fisheries, who shall hold their offices for three years, and until their successors are appointed.

SEC. 2. The commissioners of inland fisheries shall introduce, protect and cultivate fish in the inland waters of the State, and may make all needful regulations for the protection of such fish, and shall prosecute for the violation of such regulations. They may coöperate with the fish commissioners of other States, and they shall make an annual report to the general assembly of their doings, with such facts and suggestions, in relation to the object for which they were appointed, as they may deem proper.

SEC 3. The said commissioners shall cause a copy of their regulations to be filed in the office of the town clerk of any town, in which any waters stocked with fish under the authority of the preceding section of this chapter may be, and to which such regulations may apply, and shall also cause a copy of such regulations to be advertised in some newspaper published in the same county.

SEC. 4. Every person who shall violate any of the regulations made by the commissioners of inland fisheries under the authority of the provisions of the preceding sections of this chapter, or who shall take any fish, fish-spawn, or any apparatus used in hatching or protecting fish, from any pond, lake, river, or stream stocked with or set apart by said commissioners or by private parties, for the protection and cultivation of fish with the consent of the town council of the town where such cultivation is carried on, without the consent of such commissioners, or, if the cultivation of fish be carried on by a private party, without the consent of the person cultivating the same, shall, upon conviction, be fined not exceeding three hundred dollars, or be imprisoned not exceeding six months, or be both fined and imprisoned, in the discretion of the court before which the offender shall be tried.

SEC. 5. Every person who catches any fish, or uses any seine for catching fish, within one half a mile from the mouth or outlet of any fishery set apart as is herein provided, and within any waters into which the waters of such fishery are let out, shall forfeit for the first offence the sum of fifty dollars, and for every subsequent offence shall forfeit one hundred dollars, and, in addition to the penalties herein provided, shall forfeit all the apparatus by him used in violating the provisions of this section.

SEC. 6. Each of the commissioners of inland fisheries may personally or by deputy seize, and remove summarily if need be, all obstructions erected to hinder the passage of migrating fish, or which are illegally erected to obstruct, or in any way to impede, the growth and culture of fish.

SEC. 7. The prohibition to the catching of fish by hook and line, from fisheries stocked as is hereinbefore provided, shall extend and be continued for and during the term of three years from and after the time when such fishery was first established.

SEC. 8. One half of the penalties recovered for violation of the provisions of this chapter shall accrue to the complainant, and the other half thereof to the state.

SEC. 9. The commissioners of inland fisheries may take fish from the fisheries hereinbefore referred to, for any purpose connected with fish culture, or for scientific observation.

SEC. 10. Each of said commissioners may, in the discharge of his duties, enter upon and pass through or over private property, without rendering himself liable in an action of trespass.

SEC. 11. The commissioners of inland fisheries shall be allowed their actual disbursements, made in carrying into effect the provisions of this chapter.

NOV 21 1923

29,150

FIFTH ANNUAL REPORT

OF THE

Commissioners on Inland Fisheries

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION,
A. D. 1875.

HOPE

PROVIDENCE:
PROVIDENCE PRESS COMPANY, PRINTERS TO THE STATE.
1875.

NOV 21 1923

State of Rhode Island and Providence Plantations.

FIFTH ANNUAL REPORT

OF THE

Commissioners on Inland Fisheries

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION,
A. D. 1875.

PROVIDENCE:
PROVIDENCE PRESS COMPANY, PRINTERS TO THE STATE.
1875.

REPORT.

To the Honorable General Assembly, January Session, 1875*:*

The Commissioners of Inland Fisheries beg leave to present their Fifth Annual Report.

The past year has been an encouraging one for our department, on the whole. If we have met with some disappointments, we have at least learned what to avoid in the future; and our successes prompt us to continue the good work during the coming year, with high hopes of doing the State some service. A further supply of young shad and salmon have been placed in all the principal streams of the State this year; the number and location of which is herein specified.

State Hatching Establishment. Everything is in excellent order and good repair at the hatching house in Ponegansett. We have retained the services of Mr. Wm. Colwell, who gives his entire time to the superintendence of the establishment, and gives full satisfaction to the Commissioners.

Salmon. We received from Mr. Charles G. Atkins, superintendent of the Penobscot Salmon Spawning enterprise at Bucksport, Maine, 125,000 salmon ova, as the share of this State. Professor Spencer F. Baird, sent us on the part of the Government, about 92,000 salmon ova, making a total of 217,000 ova, which arrived in excellent order. About 5 per cent. were lost in hatching, which gave us about 200,000 young. We were unfortunate in losing some by muskrats, but only a comparatively small number; replaced 35,000 in Wood River; 10,000 in Pawcatuck River; 12,000 in the Slatersville branch of the Blackstone; 25,000 in the south branch of the Pawtuxet, and about 100,000 in the north branch. Very little loss occurred in the distribution. In each of the foregoing streams the salmon were distributed in a number of places.

Three years have passed since we first put salmon in these streams; the first year a comparatively small number only, largely increased the next, and this year more than doubled. Very many young salmon have been seen the past season and we hope for the best for them, but all our streams are so obstructed by dams and polluted by mills, that the fish have a hard fight for existence.

Arrangements have been made for our supply of eggs for this year, and having hatched and distributed the young as heretofore, we propose to incur no great expense at present, but to await results. About the middle of October we received from Professor Baird, United States Commissioner, 100,000 California salmon eggs, as the share of this State in the Government distribution. In hatching these we were unfortunate, losing fully one-third, owing, we think, to the eggs being too far developed when shipped on their long journey. We understand that the Commissioners of the different States, having received salmon ova from the same place, have made the same complaint, excepting Connecticut.

Shad. We have to thank Prof. Baird for a large supply of young shad, under whose superintendence the shad hatching has been carried on very extensively at Holyoke, Mass. The young fish were placed in the Blackstone, Pawtuxet, Pawcatuck and Warren Rivers, with hardly any loss, and at the expense only of transportation. We hope for good results, especially in Warren River.

Trout. We received from Mr. A. S. Collins, in January last, 24,000 trout eggs to make good the loss in last year's supply, and 30,000 from Robert Holmes, of East Wareham, Mass. The loss in hatching was not over five per cent. We placed about 20,000 in various streams in the State, put a number in the pond at the State Farm, sold a small lot to private parties, and the remainder we placed in five small ponds made for them, to be kept and distributed during the year as occasion warranted.

They did not do well owing to the drying up of the spring that fed the ponds, during the heat of the past summer. We then led a stream from the main river (Ponegansett) into the ponds, but after doing well for a time, the water got too warm, (70°), and all but about 10,000 died; these we have on hand in good condition. Another year we shall not attempt to keep any trout through the summer.

Black Bass. We are glad to be able to report a very happy state of affairs in regard to this excellent fish. Five years ago, the then commissioners, Samuel S. Foss, A. Reed and N. Dexter placed a small number of bass in four ponds, namely Herring, Sneaches, Moswanchicut, and Wanchog; no fishing was allowed for three years, and at the end of that time under restrictions, as per sections 3 and 5 of chapter 137 of the General Statutes. The fish have increased famously, and excellent fishing has been had in all these ponds except Sneaches, where they have not done so well.

Every year since, more ponds have been stocked, as well as streams, and now we are glad to report, that most all of the best waters in every town in the State has a full supply of these fish, even far away Block Island has been remembered, and two ponds stocked there. This year, Blueville pond only, has been stocked with these fish. In the future, when the close time expires from the three years' limitation, we are sure that a plentiful supply of these most excellent game fish will be found, and we shall claim the black bass as a Rhode Island fish hereafter.

The Commissioners have letters from various parties who have been very successful in bass fishing, the past summer, showing beyond a doubt, that our efforts in this branch of our department have been crowned with success.

Herring. We wish to say a good word for the much neglected herring, a fish valuable to man, and doubly valuable in the economy of nature, as affording food for other fish. In early summer, in olden time, the herring swarmed in every stream. No matter how insignificant emptying into tide water, these spawned and went their way back rejoicing. Our forefathers took what they wanted, and little dreamed that their descendants would suffer for a lack of them.

But now all is changed, the streams that knew them then, know them no more. Dams have been built, and the herring after vainly seeking a chance to obey nature's laws, and seek fresh water to deposit their spawn, have gone, heaven knows where.

In the few places where they still have access, they fare but little better, for the local inhabitant, in the pious desire to get the best of his neighbors in every way, spreads his nets at the very outlet, where the fish first make their appearance, and sweep every one to the shore.

With them disappear the codfish from our shores, for the cod feeds upon them, and can always be found in the greatest quantity where the herring abound. It has been thoroughly established, that herring do not migrate except from deep water into the fresh streams to deposit their spawn, and it may readily be seen, how their scarcity influences our deep sea fisheries.

In view of these facts, and in the strong hope that it is not too late to retrieve past errors, your Commissioners would strongly urge that some legislation may be had to protect these most prolific fish.

Narrow River, in South Kingstown, and also the Breach, in Charlestown pond, in Charlestown, should be looked to.

To fully establish these fish, a close time would be necessary, for about two years, and after that time, fishing only to a limited extent. No seine to be stretched across the stream, but only a dipnet to be used, also a close time of two days in each week.

We give here for convenience of reference, a list of the Commissioners of Inland Fisheries, of the different States:

COMMISSIONERS OF FISHERIES.

UNITED STATES.

Prof. Spencer F. Baird .... Washington, D. C.

MAINE.

E. W. Stillwell .... Bangor.

H. O. Stanley .... Dixfield.

NEW HAMPSHIRE.

Oliver N. Noyes	Henniker.
John S. Wadleigh	Laconia.
A. C. Fifield	Enfield.

VERMONT.

M. C. Edmonds	Weston.
M. Goldsmith	Rutland.

MASSACHUSETTS.

Theodore Lyman	Brookline.
E. A. Brackett	Winchester.
Asa French	South Braintree.

CONNECTICUT.

Wm. M. Hudson	Hartford.
Robert G. Pike	Middletown.
James A. Bill	Lynn.

RHODE ISLAND.

Newton Dexter	Providence.
Alfred A. Reed, Jr.	Providence.
John H. Barden	Rockland.

NEW YORK.

Horatio Seymour	Utica.
Robert B. Roosevelt	New York City.
Edward M. Smith	Rochester.

MICHIGAN.

J. J. Bagley	Detroit.
George H. Jerome	Niles.
George Clark	Ecorse.

NEW JERSEY.

J. R. Shotwell	Rakway.
G. A. Anderson	Trenton.

VIRGINIA.

Wm. B. Ball	Mid Lothian.
Asa Wall	Winchester.

ALABAMA.

Chas. S. D. Doster	Montgomery.
Robert Tyler	Montgomery.
D. R. Huntley	Courtland.

CALIFORNIA.

B. B. Redding	Sacramento.
S. R. Thockmorton	San Francisco.
J. D. Farnell	San Francisco.

PENNSYLVANIA.

H. J. Reeder	Easton.
B. L. Hewitt	Holidaysburg.
J. Duffey	Marietta.

OHIO.

John Hussy	Lockland.
J. H. Klippart	Columbus.
E. T. Sterling	Cleveland.

IOWA.

S. B. Evans	Ottumwa.
B. F. Shaw	Anamosa.
C. A. Haynes	Waterloo.

MINNESOTA.

A. W. Latham	Excelsior.

DOMINION OF CANADA.

W. T. Whitcher	Ottawa.
W. H. Fenning	St. John.

We herewith submit the financial statement for the year 1874, and would respectfully suggest that the sum of One Thousand Dollars ($1000), be appropriated to meet the expenses of 1875:

State of Rhode Island in account with Commissioners on Inland Fisheries.

DR.

To amount paid subscription to Penobscot Salmon Enterprise,	$400 00
“ “ “ expenses on salmon and black bass from California,	56 75
“ “ “ “ “ salmon to Boston, Bucksport and Slatersville,	16 60
“ “ “ “ “ salmon and black bass,	49 50
“ “ “ putting salmon in Woods River, Pawtuxet River, and Reservoir above Anthony,	41 95
“ “ “ expenses on shad from Hadley Falls, &c.,	47 50
“ “ “ “ putting shad in Pawcatuck River,	5 15
“ “ “ for labor,	499 75
“ “ “ “ traveling expenses,	101 80
“ “ “ P. C. Cranston for services as fish warden in Pawtuxet,	50 00
“ “ “ officers for watching ponds,	19 00
“ “ “ for printing notices, &c.,	18 70
“ “ “ “ postage,	7 24
“ “ “ “ sundry articles, viz: screws, coal, lumber, locks, &c.,	35 33
“ “ “ French & Mackenzie, labor on fish ladder at Pawtuxet,	8 79
	1,358 06
To balance carried forward,	609 34
	$1,967 40

CR.

1874. February 19. By balance of account rendered February 19th, 1874, as on hand,	462 40
By amount of appropriation for the year 1874,	1,500 00
By sale of fish,	5 00
	$1,967 40
1875. January 30. By balance on hand brought forward,	$609 34

JOHN H. BARDEN.
NEWTON DEXTER.
ALFRED A. REED, JR.

APPENDIX.

LAWS RELATING TO FISHERIES IN RHODE ISLAND.

CHAPTER 134, TITLE XVIII.

SECTION 1. Every person who shall set or draw any seine in any part of the river running from Warren river through the town of Barrington to the dividing line between the town of Barrington and the town of Rehoboth shall forfeit twenty dollars.

SEC. 2. Every person who shall set or draw any seine or net in Easton's pond in Newport and Middletown for the purpose of catching fish, or shall set any such seine or net in the creeks or inlets of said pond above the bridge at Easton's Beach shall be fined twenty dollars or be imprisoned ten days.

SEC. 3. If any person shall set or draw any seine or net in Wickamuet river within half a mile from the place called "the Narrows" he shall forfeit fifteen dollars.

SEC. 4. If any person shall erect or make any weir, pot, or other contrivance to obstruct the course of fish across Puncatest alias Nomquit Pond or any part thereof, or in any river or stream leading into or out of said pond at any time, he shall forfeit ten dollars.

SEC. 5. If any person shall set any hanging or mesh net in Puncatest alias Nomquit pond or in any river leading into or out of said pond from the first day of January to the first day of August in every year, he shall forfeit ten dollars.

SEC. 6. If any person shall erect or continue in Palmer's river above Kelly's bridge any weir, dam or other obstructions to prevent the free passage of fish up said river, he shall forfeit fifteen dollars for the first offence and ten dollars for every twenty-four hours any such weir, or dam, or other obstruction, shall be continued after the first twenty-four hours.

SEC. 7. If any person not at the time an inhabitant of this State shall set or draw any seine or net in Palmer's river above Kelly's bridge on Thursday, Friday or Saturday of each week, or if any person shall set or draw any seine or net in said river above said bridge on Sunday or between the setting and rising of the sun on any day, he shall forfeit for each offence fifteen dollars.

SEC. 8. If any person not at the time an inhabitant of this State shall set or keep, or cause to be kept or set within any of the waters or upon or within three miles of any shore of this State, more than two pots or nets for the catching of lobsters at any one time he shall forfeit twenty dollars for each offence.

SEC. 9. If any person shall lift or raise any pot or net, set for the catching of lobsters, without the permission of the owner thereof he shall forfeit ten dollars.

SEC. 10. The electors of the town of New Shoreham may in town meeting, called for that purpose, enact such ordinances as they may deem proper, to protect and regulate the taking of shell and other fish in Great Salt pond, and may impose penalties therefor not exceeding twenty dollars fine and three months imprisonment for any one offence.

SEC. 11. The electors of the town of Tiverton may in town meeting, called for that purpose, make such regulations for the preservation of the fish, and may exercise such control over Nomquit pond within the limits of said town, as they may think proper.

SEC. 12. No person shall between the first Monday in October and the first Monday in January erect any weir or draw any seine or net for the purpose of catching or obstructing the passage of fish at or within one hundred and sixty rods of the mouth of Petaquamscut river in South Kingstown; nor shall any person erect or put down any weir, standing seine, or trap seine, or hoop net of any kind either within or across said river at any other season of the year.

SEC. 13. Nothing in the next preceding section shall be construed to prohibit any person from using nets or fishing crafts for the catching of smelts; such as are commonly used in the smelt fishery between the first day of February and the first day of April in every year, or to prohibit the setting of gill nets for bass in said river or pond; provided, that such nets shall not exceed twenty fathoms in length, nor be set within twenty fathoms of each other; nor south of the dividing line between the lands of William G. Watson and George W. Cradell, nor within twenty rods of the narrows that connect the upper and lower ponds; nor shall any person maintain any such standing seine or net in the same place for more than twenty-four hours, if any other person demands the same place for the purpose of setting a like net or drawing a seine therein.

SEC. 14. Every person who shall violate any of the provisions of the next preceding two sections shall be fined not less than twenty or more than fifty dollars for each offence, and shall forfeit the net, seine, boat and other apparatus by him used in such violation.

SEC. 15. Every person who shall set any trap, net, or draw any seine at any time west of a straight line drawn from Quanset Point on the North side of Wickford harbor, to Rooms' Point on the south side of said harbor shall be fined not less than five dollars nor more than twenty dollars; one-half thereof to the use of the complainant, and the other half to the use of the State. Nothing in this section contained shall be construed to prevent surface, bag or purse seine fishing for catching menhaden.

SEC. 16. Every person who shall set any trap, net, or draw any seine at any time west of a line drawn from Calf Pasture Point on the north side of Allen's harbor to Rocky Point on the south side thereof, or west of a line drawn from Pojack Point on the south side of Potawamut river to Marsh Pond on the north side thereof, shall be fined not less than five dollars nor more than twenty dollars; one-half to the use of the complainant and the other half to the use of the State.

SEC. 17. No person shall from the fifteenth day of April to the fifteenth day of June, inclusive of both days, in every year or from the fifteenth day of August to the fifteenth day of December, inclusive of both days in every year, commencing at the rising of the sun on both days, erect any weir, or set or draw any seine or net for obstructing, catching or hauling of fish, within half a mile east of Point Judith ponds breach; meaning the breach for the time being into the sea; or within a point on the west side of said breach, four rods distant from Joseph Champlin's fish house (so called); or within said breach, or within any channel leading to said ponds; or within any branch thereof from the sea; or within a quarter of a mile of the entrance of such channel into said ponds or branches of said ponds; and when the fifteenth day of December happens on Sunday this prohibition shall continue to the rising of the sun on the next succeeding day.

SEC. 18. No weir shall be erected, nor any standing seine or net set across the channel, nor in Point Judith ponds within a quarter of a mile of the following places, viz.: Alden Point near where Saugatucket river flows into the said ponds; Prince's narrows, which connects the upper with the lower ponds; Stromburg Hill on Great Island; High Point (so called), on land of the heirs of Joseph Sherman, and Gooseberry Hole.

SEC. 19. No person shall, between the first Monday in April and the second Monday in June in every year, commencing at the rising of the sun and ending at the setting thereof, erect any weir or net, or draw any seine or net for the purpose of catching or obstructing the passage of fish, in any part of Point Judith pond south of a line drawn from the most northerly point of Strawberry Hill, on Treat Island, to the most northerly point of High Point in said pond.

SEC. 20. No person shall erect any weir or set or draw any seine or net for the obstructing, catching or hauling of fish within any part of said ponds, or any branch thereof, at any time from the fifteenth day of August to the fifteenth day of December in every year, commencing and ending at the rising of the sun on both of said days.

SEC. 21. No seine or net of any sort shall be used at any time within said ponds or any branch thereof, of over one hundred fathoms long, nor any standing seine or net of over twenty-five fathoms in length.

SEC. 22. No person shall set any standing seine or net at any time within forty rods of any place within said ponds or any branch thereof, where another person may have already set his standing seine or net; nor shall any person maintain any such standing seine or net for more than forty-eight hours if any other person desires to occupy the place.

SEC. 23. Any person violating any provision of the six sections next preceding shall be fined not less than twenty dollars nor more than fifty dollars, and shall also forfeit the boat, seine, net and other apparatus by him used in such violation; one-half of said fine and forfeiture to and for the use of the person so complaining, and the other half to and for the use of the State.

SEC. 24. Every person living without the State who shall take any lobsters, tautog, bass or other fish within the harbors, rivers or waters of this State, for the purpose of carrying them from thence in vessels or smacks, shall be fined ten dollars for every offence and shall forfeit all the fish or lobsters so taken.

SEC. 25. Every person who shall take any fish in any stream or fresh pond, except upon his own land, in any other way than by hook and line, or who shall take or carry away any fish from any private pond, brook, stream or preserve, or any other place made, constructed or used for the purpose of breeding or growing fish therein, without the consent of the proprietor or lessee of such pond, brook, stream or preserve, shall be punished by a fine not exceeding twenty dollars, or by imprisonment in the county jail not exceeding thirty days, or by both such fine and imprisonment, but nothing herein contained shall be construed to authorize the taking of any fish from any pond or stream stocked at the expense of the State.

SEC. 26. Every person who shall take any pickerel between the first day of April and the first day of June in each year; or any trout between the first day of September and the first day of March in each year, shall forfeit twenty dollars.

SEC. 27. All actions for the violations of the provisions of the preceding two sections, shall be commenced within thirty days after the commission of the offence, and not afterwards.

SEC. 28. If any person shall by any seine or stop net, or otherwise obstruct the channel leading from the sea into Ward's Pond and up through said pond on each side of Watermelon, Gooseberry or Larkin's Islands, he shall forfeit not less than five nor more than twenty dollars.

SEC. 29. Every person who shall erect any dam, weir or other obstruction across Mill Cove in Warwick, or from the mouth of said cove to the pond of fresh water that runs into said cove, or who shall keep up any dam or weir or other obstruction already therein made, and any owner or occupant of lands adjoining said Mill Cove or the stream leading from said pond into said cove, who shall permit any such obstructions to be erected or continued in or upon said cove or stream, whether done, erected or continued by himself or other persons adjacent to his land at any time, between the first day of March and the first day of November in every year, without leaving open through such dam or weir a sufficient way at least four feet in width, for the fish to pass, shall forfeit fifty dollars for each offence.

SEC. 30. Every person who shall fish in said cove, except with a hook and line on Saturday or Sunday, or who shall catch or hinder any alewives coming down said Mill Cove or said stream, or shall therein at any time set any weir or device to prevent the passage of the fish, shall forfeit ten dollars for each offence.

SEC. 31. Every person who shall set or draw any seine or net in said Mill Cove, or off from the mouth thereof to Long Meadow Rocks, or from the mouth thereof to the pond of fresh water that emties into said cove, between the first day of March and the fifteenth day of June, shall for each offence forfeit fifty dollars, and the boat, seines and apparatus by him used in the commission thereof.

SEC. 32. All forfeitures under this chapter shall, where there is no other provision made to the contrary, accrue one-half thereof to the use of the town where the offence shall be committed, and the other half to the use of the person sueing for the same.

CHAPTER 135.

OF THE FISHING IN PAWCATUCK RIVER.

SEC. 1. No weir or pound or other obstruction shall be erected or continued in the channel of Pawcatuck dividing the States of Rhode Island and Connecticut, so as to interfere with the main channel of said river, upon penalty of twenty dollars for the first offence, and seven dollars for every twenty-four hours, or any less space of time, any such weir or other obstruction shall be continued in the main channel of said river after the first offence.

SEC. 2. No weir or pound shall be erected or continued upon any flat, or other part of the bottom of said river, eastward or westward of the aforesaid channel of said river, between the first day of June and the twentieth day of March, annually, upon penalty of fourteen dollars for the first offence and seven dollars for every succeeding day such weir or pound shall be continued in said river, from the first day of June to the twentieth day of March, annually.

SEC. 3. No person shall fish with mesh or scoop-nets in Pawcatuck river or any of its branches, after sunset on Friday until sunrise on Monday in each week, from the twentieth day of March to the first day of June, annually, and no person shall use more than one net at a time upon penalty of five dollars for every offence.

SEC. 4. All penalties incurred for violation of any of the provisions of this chapter shall accrue, one-half thereof to the complainant, and the other half to the town where the offence is committed.

SEC. 5. The foregoing provisions of this chapter shall be considered as forming a compact with Sthe tate of Connecticut, from which this General Assembly shall not depart until the Legislature of the State of Connecticut shall agree with the Legislature of this State to a repeal thereof, alterations therein or additions thereto.

SEC. 6. If any owner of land adjoining Pawcatuck river in this State shall permit any weir, pound or other obstruction to be erected or continued upon any flat or bottom of said river, whether done, erected or continued by himself, servant or lessee, or any other person by his privy or consent. such owner shall be liable for any such breach or violation of the second section of this chapter in the same manner as though the same had been committed by such owner in person.

CHAPTER 137.

OF THE INLAND FISHERIES.

SEC. 1. The governor shall appoint three commissioners, to be known as the commissioners of inland fisheries, who shall hold their office three years and until their successors are appointed.

SEC. 2. The commissioners of inland fisheries shall introduce, protect and cultivate fish in the inland waters of the State, and may make all needful regulations for the protection of such fish and shall prosecute for the violation of such regulations. They shall coöperate with the fish commissioners of other states, and they shall make an annual report to the general assembly of their doings with such facts and suggestions in relation to the object for which they are appointed as they may deem proper.

SEC. 3. The said commissioners shall cause a copy of their regulations to be filed in the office of the town clerk of any town in which any waters stocked with fish under the authority of the preceding section of this chapter may be, and to which such regulations may apply, and shall also cause a copy of such regulations to be advertised in some newspaper published in the same county.

SEC. 4. Every person who shall violate any of the regulations made by the commissioners of inland fisheries under the authority of the provisions of the preceding sections of this chapter, or who shall take any fish, fish-spawn or any apparatus used in hatching or protecting fish, from any pond, lake, river or stream, stocked with, or set apart by said commissioners or by private parties for the protection and cultivation of fish, with the consent of the town council of the town where such cultivation is carried on, without the consent of such commissioner, or, if the cultivation of fish be carried on by a private party, without the consent of the person cultivating the same, shall, upon conviction, be fined not exceeding three hundred dollars, or be imprisoned not exceeding six months, or be both fined and imprisoned, in the discretion of the court before which the offender shall be tried.

SEC. 5. Every person who catches any fish or uses any seine for catching fish, within one-half a mile from the mouth or outlet of any fishery set apart as is herein provided, and within any waters into which the waters of such fishery are let out, shall forfeit for the first offence the sum of fifty dollars and for every subsequent offence shall forfeit one hundred dollars, and in addition to the penalties herein provided, shall forfeit all the apparatus by him used in violating the provisions of this section.

SEC. 6. Each of the commissioners of inland fisheries may, personally or by deputy, seize and remove summarily, if need be, all obstructions erected to hinder the passage of migrating fish, or which are illegally erected to obstruct or in any way to impede the growth and culture of fish.

SEC. 7. The prohibition to the catching of fish by hook and line from fisheries stocked as is hereinbefore provided, shall extend and be continued for, and during, the term of three years from and after the time when such fishing was first established.

SEC. 8. One-half of the penalties recovered for violation of the provisions of this chapter shall accrue to the complainant and the other half thereof to the State.

SEC. 9. The commissioners of inland fisheries may take fish from the fisheries hereinbefore referred to for any purpose connected with fish culture, or for scientific observation.

SEC. 10. Each of said commissioners may, in the discharge of his duties, enter upon and pass through or over private property without rendering himself liable in an action of trespass.

SEC. 11. The commissioners of inland fisheries shall be allowed their actual disbursements made in carrying into effect the provisions of this chapter.

CHAPTER 138.

GENERAL PROVISIONS FOR THE PROTECTION OF FISHERIES.

SEC. 1. Every person who shall throw into, or deposit in, or cause to be thrown into or to be deposited in any of the public tidewaters of this State or upon the shores of any such tidewaters, any fish offal or any water impregnated with fish, and any person who shall cause any deleterious substance resulting from the smelting or manufacture of copper, or from other manufactures or from other sources, which is destructive to fish, or which repels them from coming into the said public waters, or which shall do anything which tends to drive them therefrom, to be emptied, deposited or run into the said public waters, shall forfeit one hundred dollars.

SEC. 2. Every vessel, craft, boat or floating apparatus of any kind whatever, employed in the procuring of fish oil, or in the dressing of bait for the mackerel fisheries, or the dressing of fish for other purposes, in violation of this chapter, shall be liable for any forfeiture and costs resulting from prosecution hereunder, and the same may be attached on the original writ and held as other personal property attached may be held, to secure judgment which may be recovered in any action brought to enforce any such forfeiture, and any person upon view of any offence in violation of this chapter, may seize and detain any vessel, craft, boat or floating apparatus, the same to be attached for a period not exceeding six hours.

SEC. 3. Every person who shall boil any menhaden fish, or press any such fish for the purpose of extracting oil therefrom, on board of any vessel on any of the public tidewaters, shall be fined not exceeding fifty dollars.

CHAPTER 281.

An Act in amendment of Chapter 134 of the General Statutes, of certain Fisheries.

[Passed March 12, 1873.]

SEC. 1. No person, not a member of the Narragansett tribe of Indians, shall, without the consent of the council of said tribe being first obtained, erect any weir or set or draw any seine or net for the obstructing, catching or hauling any fish or take any fish with hook or line or in any manner, in the ponds or other waters within the bounds of the land belonging to said tribe.

SEC. 2. Every person violating the preceding section shall forfeit not less than five nor more than twenty dollars for each offence, to be recovered on complaint made by the commissioner of the Indian tribe, for the benefit of said tribe.

CHAPTER 282.

An Act in amendment of, and in addition to Chapter 137, Title XVIII. of the General Statutes, "Of the Inland Fisheries."

[Passed March 11, 1873.]

SEC. 1. No person shall take or catch fish of any kind from any of the inland waters of this State set apart by the commissioners of inland fisheries thereof for the cultivation of fish except at such times and in such manner as is hereinafter provided.

SEC. 2. Section 7 of said chapter 137 of the General Statutes of this State is so far amended as to allow the catching of fish through the ice only and with hook and hand-line only, in those ponds set apart for the cultivation of black bass during the months of December, January and February of each and every year from the passage of this act, until the expiration of the three years mentioned in section 7 of said chapter.

SEC. 3. After the expiration of said three years no fish shall be taken by any person from any waters legally set apart by said commissioners for the cultivation of black bass during the months of March, April and May, and only by hook and hand-line as aforesaid.

SEC. 4. After the expiration of said three years no fish shall be taken by any person from any waters legally set apart by said commissioners for the cultivation of shad or salmon, or within one mile of the outlet of the streams so set apart except from and after the fifteenth day of April until the fifteenth day of July of each and every year, nor at any time except by hook and hand-line, or by not less than three inch mesh nets or seine or seines.

SEC. 5. No person shall take any fish from any of the waters of this State legally set apart for the cultivation of fish during the times allowed to be taken by this act except on Thursdays, Fridays and Saturdays during said term, except in the months of December, January and February.

SEC. 6. Nothing in this act shall prevent the commissioners of inland fisheries from taking fish from any of said waters as is now permitted by section 9 of chapter 137 of the General Statutes.

SEC. 7. Any person violating any of the provisions of this act shall be subject to the penalties for catching fish as imposed by section 5 of said chapter 137, of which this act is an amendment.

SEC. 8. All acts and parts of acts inconsistent herewith are hereby repealed.

SEC. 9. This act shall take effect immediately on and after its passage.

NOV 21 1923

State of Rhode Island and Providence Plantations.

29,150

ANNUAL REPORT

OF THE

Commissioners on Inland Fisheries

MADE TO THE

GENERAL ASSEMBLY

OF THE

STATE OF RHODE ISLAND,

AT ITS

January Session, A. D. 1877.

PROVIDENCE:
ANGELL, BURLINGAME & CO., PRINTERS TO THE STATE.
1877.

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1877.

REPORT.

To the Honorable General Assembly of the State of Rhode Island, at its January Session, 1877 *:*

The Commissioners of Inland Fisheries beg leave to submit their seventh annual report:

The State hatching house and its appurtenances are in excellent condition. We received the past year from Mr. C. S. Atkins 20,000 land-locked or Schoodic salmon ova. These were hatched and distributed as follows, with a loss of only about 2 per cent.:

Wallum Pond	**in Burrillville.**
Moswansicut Pond	**in Scituate.**
Steers Pond	**in Scituate.**
Searles Pond	**in Foster.**
Lilly Pond	**in Foster.**
Gorton's Pond	**in Warwick.**
Warwick Pond	**in Warwick.**
Beach Pond	**in Richmond.**

The following ponds have been stocked with black bass by the present commissioners, which we append in this order for convenience of reference:

JUNE AND JULY, 1870.

Wauchog Pond	**in Charlestown.**
Moswansicut Pond	**in Scituate.**
Sneach Pond	**in Cumberland.**
Herring Pond	**in Burrillville.**

JUNE AND JULY, 1871.

Steere's Pond	in Scituate.
Hope Pond	in Scituate.
Ponegansett Pond	in Scituate.
Searle's Pond	in Foster.
Spear's Pond	in Foster.
Scott's Pond	in Lincoln.
New Reservoir	in Lonsdale.
Warwick Pond	in Warwick.
Gorton Pond	in Warwick.

JUNE AND JULY, 1872.

Stafford Pond	in Tiverton.
Easton's Pond	in Newport and Middletown.

JUNE AND JULY, 1873.

Yawgoo Pond	in South Kingstown.
Worden's Pond	in South Kingstown.
Bellville Pond	in North Kingstown.
Johnson's Pond	in Coventry.
Wickaboxet Pond	in West Greenwich.
Deep Pond	in Exeter.
Yawgook Pond	in Hopkinton.
Eaton's Pond	in Newport.
Two Ponds	on Block Island.

JUNE AND JULY, 1874.

Blue Pond	in Hopkinton

We also received 120,000 salmon ova which were hatched with about a like success, and placed in the following-named streams: 20,000 in Wood and Pawcatuck rivers, 15,000 in the Slatersville Branch of the Blackstone, and 80,000 in the Pawtuxet and its branches.

In October last, we received a letter from Prof. Baird, the United States Commissioner, asking us how many California eggs we would take; but the extreme drought of the past summer made us unable to avail ourselves of his kindness. Under the present circumstances, we believe we have in the past five years, done all that is necessary to demonstrate if our streams are capable of supporting salmon. Of course the very numerous dams will forever bar the return of these fish to the upper parts of the streams, where they pass the first year, and some authorities say, two of their lives. Once over the dams, there is no return for them. Their instinct at a certain age prompting them to seek the sea. Now all we can demonstrate is, will our streams support these fish in their young state till that age is reached. That they once did is certain, but the quality and temperature of the water has undergone such a change, that he would be a bold fish commissioner, who would make a positive statement. We are encouraged to hope they will, for very many of these young salmon have been taken, by various modes of capture, in different stages of growth. But it is difficult to study what is going on under the water, and so we at present are more or less in the dark. Five years ago a great hue and cry was raised for fishways over the dams in all the New England States; many thousands of dollars have been spent on them, and with our present light we cannot but congratulate the people of Rhode Island on holding aloof up to date.

BLACK BASS.

We are happy to be able to reiterate all we have said in our past reports as to our success in making this capital fish a native of our waters. The bass have become very popular and are destined to become more so, as our people learn better how to take them.

The past season we have only placed them in one locality namely, the Stillwater Reservoir in Smithfield. Private parties have however stocked numerous ponds with fish taken from the waters previously stocked by the State. A good many have been taken from the Blackstone River the past year which no doubt found their way there from Whitinsville. The reservoir at that place having given away some five years ago. To show the rapidity of the increase of these fish; five years since in October, 8 bass were put into Steer's pond in Rockland, of about 8 acres in area, and about 13 feet in average depth. Last year the pond was drawn down to repair the dam, and a number of bass were taken, from 3 to 4 pounds in weight, and small ones innumer ble. Quite a number we hear have been taken through the ice the past winter, by parties fishing for pickerel, some of upwards of 4 pounds in weight-

Bass make a round nest in the gravel near the shore in from 3 to 5 feet of water, and deposit their eggs about June 1st, or a little later ; as near as can be ascertained about two weeks are required to hatch the eggs, and as soon as the sack is absorbed the little ones retire to the grass and weeds along the shore for safety. The old fish during the time the eggs and young are in the. nest, are watching near by, and driving off all intruders, The young seem to grow very rapidly.

SHAD.

Owing to the extreme heat of the past season we were unable to get our usual supply of young shad. The source of supply is the Connecticut river, where the United States Commissioner now has charge of the works. The labor there was rendered almost naught the past summer by the over heating of the water, and we, as well as the other New England States suffered in consequence. We hope the coming season to do better, for our past success with shad has been very great, and these fish have been more abundant and cheaper in our State for the past two years than for a great length of time, and a good portion of our supply was taken in our own immediate waters. All the expense necessary to obtain the young fish, is for transportation, they being furnished free.

TROUT.

We have done nothing with trout for the past two years owing to the extreme droughts we are occasionally subjected to, our supply of water sometimes gives out, and then in a very short time our labors and outlay are vain. We do not recommend any one attempting to raise these fish on a large scale unless sure of an unfailing supply of water.

IN CONCLUSION.

We would say as our report briefly shows that the past year has not been an active one in our department for the reason that we having accomplished what was needful in the few previous years in stocking the waters of the State, must now lay upon our oars and watch the success of our labors. We think we do not claim too much in saying that with black bass it has been entire and fully equal to our most sanguine expectations (and fish commissioners are always sanguine.) Shad have increased in our waters vastly within the past three years, and as for salmon. we hope, and can say no more, and we would only add that our sincere wish is that the same unanimity of wise and generous action would prevail in our councils and community, in regard to our Bay fisheries, as have been granted to us in our efforts to improve those of our inland waters.

Aware that we are now upon dangerous grounds and that the pursuance of the topic will doubtless bring us a strong hint to stick to our legitimate business, we close our report with a statement of our cash account, and would say that no appropriation is needed for the coming year.

The following is a list of the commissioners of the various states.

COMMISSIONERS OF FISHERIES.

UNITED STATES.

Prof. Spencer F. Baird	Washington, D. C.

ARKANSAS.

N. H. Fish	Pine Buffs
J. R. Steelman	Little Rock
N. B. Pearce	Fayetville

CALIFORNIA.

B. B. Redding	Sacramento
S. R. Throckmorton	San Francisco
J. F. Farwell	San Francisco

CONNECTICUT.

William M. Hudson	Hartford
Robert G. Pike	Middletown
James A. Bill	Lyme

GEORGIA.

Thomas P. James	

(Duties embracing the work of the fish interest assigned to Commissioner of Agriculture).

IOWA.

Samuel B. Evans	Ottumwa
B. F. Shaw	Anamora
Charles A. Haynes	Waterloo

KENTUCKY.

Pack Thomas	Louisville.

MAINE.

E. M. Stillwell	Bangor.
Henry O. Stanfield	Dixfield.

MARYLAND.

T. B. Ferguson	Baltimore.
T. W. Downes	Denton.

MASSACHUSETTS.

Theodore Lyman	Brookline.
Asa French	South Braintree.
E. A. Brackett	Winchester

MICHIGAN.

George Clark	Ecorse.
A. J. Kellogg	Allegan.
E. R. Miller	Richland.

MINNESOTA.

R. O. Sweeney	St. Paul.
Robert Owesly	.....
William Golcher	....

NEW HAMPSHIRE.

Colonel Samuel Webber	Manchester.
Albina H. Powers	Grantham.
Luther H. Hayes	Milton.

NEW YORK.

Horatio Seymour	Utica.
Robert R. Roosevelt	New York City.
Edward M. Smitts	Rochester.

NEW JERSEY.

B. P. Howell	Woodbury.
J. R. Shortwell	Rahway.
G. A. Anderson	Trenton.
George Ricardo	Hackensack.

OHIO.

John C. Fisher	Coshocton.
John H. Klipput	Columbus.
Robert Cummings	Toledo.

PENNSYLVANIA.

J. H. Reeder	Easton.
B. L. Hewett	Hollidaysburg.
James Duffy	Marietta.

RHODE ISLAND.

Newton Dexter	Providence.
Alfred A. Reed, Jr.	Providence.
John H. Barden	Scituate.

UTAH TERRITORY.

A. P. Rockwood	Salt Lake City.

(Superintendent of Fisheries, Zion's Co-operative Society.)

VERMONT.

M. C. Edmunds	Weston.
M. Goldsmith	Rutland.

VIRGINIA.

A. Moseley	Richmond.
W. B. Robertson	Lynchburg.
M. G. Ellyzer	Blacksburg.

WISCONSIN.

William Welch	Madison.
A. Palmer	Bescobel.
P. R. Hoy	Racine

DOMINION OF CANADA.

W. F. Whitcher	Ottawa.
W. H. Vining	St. John, N. B.

(Inspector of fisheries for New Brunswick and Nova Scotia.)

ALFRED. A. REED, Jr.,
NEWTON DEXTER,
JOHN H. BARDEN.

State of Rhode Island in count with Commissioners on Inland Fisheries.

Dr.

1877.			
Jan. 1st.	To amount paid for labor	$225 75	
	" " watching Moswansicut Pond, Pawtuxet Cove and River	55 00	
	" " expenses to Holyoke for shad	14 10	
	" " 105 black bass	3 00	
	" " express on salmon eggs	34 63	
	" " expenses of J. H. Barden, Commissioner to Centennial Fish Meeting	45 18	
	" " rent of land	13 00	
	" " stationery, etc.	5 50	
	" " traveling expenses	14 15	
	" " placing land-locked salmon in following ponds, viz.: Moswansicut, Johnson, Beach, Wickaboxet, Millville, Rockville, Spring Grove, Tucker, Wells, Jackson, Harrisville Natick, Pontiac, Warwick, Hope, Arctic, Washington, Quidnick, Crompton, River Point, Mashapaug and Lilly and Centreville; Slatersville River, Pawcatuck River, and six different places on Hood's River	61 50	
		$471 81	
	Balance carried forward	488 30	
			$960 11

Cr.

1877.			
Feb. 29th.	By balance on hand	$460 11	
	By amount of appropriation for the year 1876	500 00	
			$960 11
1877.			
Jan. 1st.	By balance cash on hand brought forward	$488 30	

PROVIDENCE *January* 1st, 1877.

NOV 21 1923

State of Rhode Island and Providence Plantations.

29,160

EIGHTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, A. D. 1878,

TOGETHER WITH THE LAWS OF THE STATE, NOW IN FORCE, RELATING TO INLAND FISHERIES.

OFFICE OF THE SECRETARY OF STATE, APRIL, 1878.

PROVIDENCE:
E. L. FREEMAN & CO., PRINTERS TO THE STATE.
1878.

NOV 21 1923

State of Rhode Island and Providence Plantations.

EIGHTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, A. D. 1878,

TOGETHER WITH THE LAWS OF THE STATE, NOW IN FORCE, RELATING TO INLAND FISHERIES.

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RESOLUTION

INSTRUCTING THE SECRETARY OF STATE TO PREPARE A MANUAL FOR THE USE OF THE COMMISSIONERS OF INLAND FISHERIES.

(Passed April 12, 1878.)

Resolved, (The honorable senate concurring herein,) that the secretary of state be instructed to prepare for the use of the commissioners of inland fisheries a manual containing the laws of the state now in force relating to inland fisheries, and the report of the said commissioners to this general assembly, and that he cause five hundred copies thereof to be printed.

A true copy,

WITNESS: J. M. ADDEMAN,
Secretary of State.

REPORT.

To the Honorable General Assembly of the State of Rhode Island, at its January Session, 1878:

The Commissioners of Inland Fisheries submit their eighth annual report.

The hatching-house and all its appurtenances at Ponegansett are in excellent condition. Owing to the failure of our springs last fall, 1877, we did not think it best to attempt the hatching of the California salmon eggs offered us by Prof. Baird, as failure would have been assured and the eggs wasted, so that the past year we have done nothing with salmon.

Our plan has been to watch as carefully as possible for the appearance of salmon in the streams stocked by us the previous years. The presence of dams in large numbers on the various streams, and the presence of innumerable traps and pounds in the bay, made the return of the fish to the upper waters an impossibility, and their reaching even the mouth of the streams a problem.

When the present Commissioners first assumed office these facts were fully thought of, and the question whether any attempt had better be made without first causing fishways to be put over all the dams was agitated.

The expense of this would have been very large, and the opposition would have been great, and much litigation would have ensued in consequence, and still, unless the obstacles were removed, and traps and pounds abolished, success would have been more than doubtful.

To hatch and place the young salmon in the streams was not much trouble, and small expense; the only thing else to be done was to renew the supply from year to year and watch for results, with all the obstacles against them that it is possible to conceive of.

This has been done, and we have to report that a good many salmon have been taken in the past two years that we have record of, and, no doubt, many more unreported.

The largest weighed ten pounds, and was taken at the foot of the falls, at Pawtucket, last June. Smaller ones were taken in the Pawtuxet, between the first dam and Pontiac, and a number near Westerly, below the first dam, on the Pawcatuck; none larger than two and one-half pounds.

These facts prove conclusively that there is nothing in the impurities of the waters to prevent success.

In spite of all obstacles, the ten-pound fish must have lived three or four years and gone down to and back from the ocean at least once, and with obstacles removed nothing seems to reason against a fair per cent. of fish doing likewise.

So that we think it fair grounds to assume that, with the abolishment of pound-nets and the erection of fishways over all dams, salmon can be brought once more to be a Rhode Island fish with certainty.

The Commissioners having worked out this problem to their own satisfaction, and they hope to all fair minds, it remains for the people to decide whether or no these things will be done.

SHAD.

Last year we put one hundred thousand young shad in the Blackstone, Warren and Barrington rivers. We failed to get any for the Pawtuxet on account of the falling of the water in the Connecticut, which put a stop to the hatching; and we should have left the Pawcatuck out in the cold anyhow, on account of the very numerous heart-seines, traps and pounds within four miles of the mouth of that river at Westerly, at least thirty in number, most of them with a half-inch mesh. It is a waste of time to try to do anything under such circumstances. In our own bay shad operations have been a success.

BLACK BASS.

As before reported, black bass are a complete success, and all, or nearly all, of the waters in the State suitable for them are now stocked with them. Certain parties profess to regret this fact and to wish for the good old times when nothing but the all-devouring and worthless pickerel was the only fish to be taken. We can only say "such men are dangerous" and partake, we fear, of the nature of the fish whose praise they sing.

LAND-LOCKED SALMON.

We received from Mr. Atkins, of Maine, through Prof. Baird, ten thousand eggs in February and hatched them with very small loss, and they are now about ready to distribute.

In conclusion, the Commissioners respectfully recommend the passage of the act amending Sections 29 and 31 of Chapter 134 of the General Statutes, now in the hands of the Committee on Fisheries of the Senate.

We close our report for the year with our cash account annexed.

STATE OF RHODE ISLAND IN ACCOUNT WITH COMMISSIONERS ON INLAND FISHERIES.

Dr.

To amount paid for labor	$100 00	
To expense getting shad and stocking Blackstone, Barrington and Warren rivers	39 31	
To express on salmon spawn from Maine	5 30	
To expenses of Commissioners to New England Commissioners' meeting in Boston	15 95	
Postage	1 12	
		$161 68
Balance carried forward		326 62
		$488 30

Cr.

By balance cash on hand January 1, 1877	$488 30

JOHN H. BARDEN,
ALFRED A. REED, Jr.,
NEWTON DEXTER.

Providence, April 9, 1878.

APPENDIX.

LAWS RELATING TO INLAND FISHERIES IN RHODE ISLAND, IN FORCE APRIL, 1878.

GENERAL STATUTES.

CHAPTER 134.

OF CERTAIN FISHERIES.

SECTION 1. Every person who shall set or draw any seine in any part of the river running from Warren River through the town of Barrington to the dividing line between the town of Barrington and the town of Rehoboth shall forfeit twenty dollars.

SEC. 2. Every person who shall set or draw any seine or net in Easton's Pond in Newport and Middletown for the purpose of catching fish, or shall set any such net or seine in the creeks or inlets of said pond above the bridge at Easton's Beach shall be fined twenty dollars or be imprisoned ten days.

SEC. 3. If any person shall set or draw any seine or net in Kickamuit River within half a mile from the place called the Narrows he shall forfeit fifteen dollars.

SEC. 4. If any person shall erect or make any weir, pot, or other contrivance to obstruct the course of fish across Puncatest, alias Nomquit Pond, or any part thereof, or in any river or stream leading into or out of said pond at any time, he shall forfeit ten dollars.

SEC. 5. If any person shall set any hanging or mesh net in Puncatest, alias Nomquit Pond, or in any river leading into or out of said pond from the first day of January to the first day of August in every year, he shall forfeit ten dollars.

SEC. 6. If any person shall erect or continue in Palmer's River above Kelly's Bridge any weir, dam or other obstruction to prevent the free passage of fish up said river, he shall forfeit fifteen dollars for the first offence and ten dollars for every twenty-four hours any such weir, or dam, or other obstruction, shall be continued after the first twenty-four hours.

SEC. 7. If any person not at the time an inhabitant of this state shall set or draw any seine or net in Palmer's River above Kelly's Bridge on Thursday, Friday or Saturday of each week, or if any person shall set or draw any seine or net in said river above said bridge on Sunday or between the setting and rising of the sun on any day, he shall forfeit for each offence fifteen dollars.

SEC. 8. If any person not at the time an inhabitant of this state shall set or keep, or cause to be kept or set within any of the waters or upon or within three miles of any shore of this state, more than two pots or nets for the catching of lobsters at any one time he shall forfeit twenty dollars for each offence.

SEC. 9. If any person shall lift or raise any pot or net, set for the catching of lobsters, without the permission of the owner thereof he shall forfeit ten dollars.

SEC. 10. The electors of the town of New Shoreham may in town meeting, called for that purpose, enact such ordinances as they may think proper, to protect and regulate the taking of shell and other fish in Great Salt Pond, and may impose penalties therefor not exceeding twenty dollars fine and three months' imprisonment for any one offence.

SEC. 11. The electors of the town of Tiverton may in town meeting, called for that purpose, make such regulations for the preservation of the fish, and may exercise such control over the fisheries of Nomquit Pond within the limits of said town, as they may think proper.

SEC. 12. No person shall, between the first Monday in October and the first Monday in January, erect any weir or draw any seine or net for the purpose of catching or obstructing the passage of fish at or within one hundred and sixty rods of the mouth of Petaquamscut River in South Kingstown; nor shall any person erect or put down any weir, standing seine, or trap seine, or hoop net of any kind either within or across said river at any other season of the year.

SEC. 13. Nothing in the next preceding section shall be construed to prohibit any person from using nets or fishing crafts for the catching of smelts; such as are commonly used in the smelt fishery between the first day of February and the first day of April in every year, or to prohibit the setting of gill nets for bass in said river or pond; provided, that such nets shall not exceed twenty fathoms in length, nor be set within twenty fathoms of each other; nor south of the dividing line between the lands of William G. Watson and George W. Crandall; nor within twenty rods of the narrows that connect the upper and lower ponds; nor shall any person maintain any such standing seine or net in the same place for more than twenty-four hours, if any other person demands the same place for the purpose of setting a like net or drawing a seine therein.

SEC. 14. Every person who shall violate any of the provisions of the next preceding two sections shall be fined not less than twenty dollars or more than fifty dollars for each offence, and shall forfeit the net, seine, boat and other apparatus by him used in such violation.

SEC. 15. Every person who shall set any trap, net, or draw any seine at any time west of a straight line drawn from Quanset Point on the north side of Wickford harbor to Room's Point on the south side of said harbor, shall be fined not less than five dollars nor more than twenty dollars; one-half thereof to the use of the complainant, and the other half to the use of the state. Nothing in this section contained shall be construed to prevent surface, bag or purse seine fishing for catching menhaden.

SEC. 16. Every person who shall set any trap, net, or draw any seine at any time west of a line drawn from Calf Pasture Point on the north side of Allen's harbor to Rocky Point on the south side thereof, or west of a line drawn from Pojack Point on the south side of Potawamut River to Marsh Point on the north side thereof, shall be fined not less than five dollars nor more than twenty dollars; one-half to the use of the complainant and the other half to the use of the state.

SEC. 17. No person shall from the fifteenth day of April to the fifteenth day of June, inclusive of both days, in every year, or from the fifteenth day of August to the fifteenth day of December, inclusive of both days in every year, commencing at the rising of the sun on both days, erect any weir, or set or draw any seine or net for obstructing, catching or hauling of fish, within half a mile east from Point Judith ponds' breach, meaning the breach for the time being into the sea, or within a point on the west side of said breach, four rods distant from Joseph Champlin's fish house (so-called), or within said breach, or within any channel leading to said ponds, or any branch thereof from the sea, or within a quarter of a mile of the entrance of such channel into said ponds or branches of said ponds; and when the fifteenth day of December happens on Sunday this prohibition shall continue to the rising of the sun on the next succeeding day.

SEC. 18. No weir shall be erected, nor any standing seine or net set across the channel, nor in Point Judith ponds within a quarter of a mile from the following places, viz.: Alder Point near where Saukatucket River flows into the said ponds; Prince's Narrows, which connect the upper with the lower ponds; Strawberry Hill on Great Island; High Point (so-called), on land of the heirs of Joseph Sherman, and Gooseberry Hole.

SEC. 19. No person shall, between the first Monday in April and the second Monday in June in every year, commencing at the rising of the sun and ending at the setting thereof, erect any weir or net, or draw any seine or net for the purpose of catching or obstructing the passage of fish, in any part of Point Judith Pond south of a line drawn from the most northerly point of Strawberry Hill, on Great Island, to the most northerly point of High Point in said pond.

SEC. 20. No person shall erect any weir or set or draw any seine or net for the obstructing, catching or hauling of fish within any part of said ponds, or any branch thereof, at any time from the fifteenth day of August to the fifteenth day of December in every year, commencing and ending at the rising of the sun on both of said days.

SEC. 21. No seine or net of any sort shall be used at any time within said ponds or any branch thereof, of over one hundred fathoms long, nor any standing seine or net of over twenty-five fathoms in length.

SEC. 22. No person shall set any standing seine or net at any time within forty rods of any place within said ponds or any branch thereof, where another person may have already set his standing seine or net; nor shall any person maintain any such standing seine or net in the same place for more than forty-eight hours if any other person desires to occupy the place.

SEC. 23. Every person violating any provision of the six sections next preceding shall be fined not less than twenty dollars nor more than fifty dollars, and shall also forfeit the boat, seine, net and other apparatus by him used in such violation; one-half of said fine and forfeiture to and for the use of the person so complaining, and the other half to and for the use of the state.

SEC. 24. Every person living without the state who shall take any lobsters, tautog, bass or other fish within the harbors, rivers or waters of this state, for the purpose of carrying them from thence in vessels or smacks, shall be fined ten dollars for every offence and shall forfeit all the fish or lobsters so taken.

SEC. 25. Every person who shall take any fish in any stream or fresh pond, except upon his own land, in any other way than by hook and line, or who shall take or carry away any fish from any private pond, brook, stream, preserve, or any other place made, constructed or used for the purpose of breeding or growing fish therein, without the consent of the proprietor or lessee of such pond, brook, stream or preserve, shall be punished by a fine not exceeding twenty dollars, or by imprisonment in the county jail not exceeding thirty days, or by both such fine and imprisonment; but nothing herein contained shall be construed to authorize the taking of any fish from any pond or stream stocked at the expense of the state.

SEC. 26. (As amended by chapter 495, passed June 15, 1875; chapter 540, passed April 19, 1876; and chapter 678, passed April 12, 1878.) Every person who shall take any trout between the fifteenth day of August and the first day of March in each year, shall forfeit twenty dollars for each offence.

Sec. 27. All actions for violations of the provisions of the preceding two sections shall be commenced within thirty days after the commission of the offence, and not afterwards.

Sec. 28. If any person shall by any seine or stop net, or otherwise obstruct the channel leading from the sea into Ward's Pond and up through said pond on each side of Watermelon, Gooseberry or Larkin's islands, he shall forfeit not less than five nor more than twenty dollars.

Sec. 29. (As amended by chapter 677, passed April 12, 1878.) Every person who shall erect any dam, weir, or other obstruction across Mill Cove in Warwick, or from the mouth of said cove to the pond of fresh water that runs into said cove, or such streams as run into said pond, or who shall keep up any dam, or weir, or other obstruction therein made, and any owner or occupant of lands adjoining said Mill Cove or the stream leading from said pond into said cove, who shall permit any such obstruction to be erected or continued in or upon said cove or stream, whether done, erected, or continued by himself, or other persons, adjacent to his land, at any time between the first day of March and the first day of November in any year, shall forfeit one hundred dollars for each offence.

Sec. 30. Every person who shall fish in said cove, except with a hook and line, on Saturday or Sunday, or who shall catch or hinder any alewives coming down said Mill Cove or said stream, or shall therein at any time set any weir or device to prevent the passage of the fish, shall forfeit ten dollars for each offence.

Sec. 31. (As amended by chapter 677, passed April 12, 1878.) Every person who shall set or draw any seine or net in said Mill Cove, or off from the mouth thereof to Long Meadow Rocks, or from the mouth thereof to the pond of fresh water which empties into said cove, between the first day of March and the fifteenth day of June, in any year, or who shall take any alewives from said pond, or streams flowing into said pond, between the first day of March and the first day of November, in any year, shall for each offence forfeit one hundred dollars, and the boats, seines and other apparatus used in the commission thereof; provided, however, that nothing in said chapter shall be construed to prohibit any person from fishing for alewives in said cove or stream running from said pond into said cove, with a bowed net not larger than twelve feet around the mouth of said net, on days other than those excepted in section 30 of chapter 134.

SEC. 32. All forfeitures under this chapter shall, where there is no other provision made to the contrary, enure one-half thereof to the use of the town where the offence shall be committed, and the other half to the use of the person suing for the same.

CHAPTER 135.

OF THE FISHERY IN PAWCATUCK RIVER.

SECTION 1. No weir or pound or other obstruction shall be erected or continued in the channel of Pawcatuck River dividing the states of Rhode Island and Connecticut, so as to interfere with the main channel of said river, upon penalty of twenty dollars for the first offence, and seven dollars for every twenty-four hours, or any less space of time, any such weir or other obstruction shall be continued in the main channel of said river after the first offence.

SEC. 2. No weir or pound shall be erected or continued upon any flat, or other part of the bottom of said river, eastward or westward of the aforesaid channel of said river, between the first day of June and the twentieth day of March, annually, upon penalty of fourteen dollars for the first offence and seven dollars for every succeeding day such weir or pound shall be continued in said river, from the first day of June to the twentieth day of March, annually.

SEC. 3. No person shall fish with mesh or scoop nets in Pawcatuck River or any of its branches, after sunset on Friday until sunrise on Monday in each week, from the twentieth day of March to the first day of June, annually; and no person shall use more than one net at a time, upon penalty of five dollars for every offence.

SEC. 4. All penalties incurred for violation of any of the provisions of this chapter shall enure, one-half thereof to the complainant, and the other half to the town where the offence is committed.

SEC. 5. The foregoing provisions of this chapter shall be considered as forming a compact with the state of Connecticut, from which this general assembly will not depart until the legislature of the state of Connecticut shall agree with the legislature of this state to a repeal thereof, alterations therein or additions thereto.

SEC. 6. If any owner of land adjoining Pawcatuck River in this state shall permit any weir, pound or other obstruction to be erected or continued upon any flat or bottom of said river, whether done, erected or continued by himself, servant, lessee, or any other person by his privity or consent, such owner shall be liable for any such breach or violation of the second section of this chapter in the same manner as though the same had been committed by such owner in person.

CHAPTER 137.

OF THE INLAND FISHERIES.

SECTION 1. The governor shall appoint three commissioners, to be known as the commissioners of inland fisheries, who shall hold their offices for three years and until their successors are appointed.

SEC. 2. The commissioners of inland fisheries shall introduce, protect and cultivate fish in the inland waters of the state, and may make all needful regulations for the protection of such fish and shall prosecute for the violation of such regulations. They may coöperate with the fish commissioners of other states, and they shall make an annual report to the general assembly of their doings with such facts and suggestions in relation to the object for which they were appointed as they may deem proper.

SEC. 3. The said commissioners shall cause a copy of their regulations to be filed in the office of the town clerk of any town in which any waters stocked with fish under the authority of the preceding section of this chapter may be, and to which such regulations may apply, and shall also cause a copy of such regulations to be advertised in some newspaper published in the same county.

SEC. 4. Every person who shall violate any of the regulations made by the commissioners of inland fisheries under the authority of the provisions of the preceding sections of this chapter, or who shall take any fish, fish-spawn or any apparatus used in hatching or protecting fish, from any pond, lake, river or stream, stocked with, or set apart by said commissioners or by private parties for the protection and cultivation of fish, with the consent of the town council of the town where such cultivation is carried on, without the consent of such commissioners, or, if the cultivation of fish be carried on by a private party, without the consent of the person cultivating the same, shall, upon conviction, be fined not exceeding three hundred dollars, or be imprisoned not exceeding six months, or be both fined and imprisoned, in the discretion of the court before which the offender shall be tried.

SEC. 5. Every person who catches any fish or uses any seine for catching fish, within one-half a mile from the mouth or outlet of any fishery set apart as is herein provided, and within any waters into which the waters of such fishery are let out, shall forfeit for the first offence the sum of fifty dollars and for every subsequent offence shall forfeit one hundred dollars, and in addition to the penalties herein provided, shall forfeit all the apparatus by him used in violating the provisions of this section.

SEC. 6. Each of the commissioners of inland fisheries may, personally or by deputy, seize and remove summarily, if need be, all obstructions erected to hinder the passage of migrating fish, or which are illegally erected to obstruct or in any way to impede the growth and culture of fish.

SEC. 7. The prohibition to the catching of fish by hook and line from fisheries stocked as is hereinbefore provided, shall extend and be continued for, and during, the term of three years from and after the time when such fishery was first established. [Amended. See chapter 282, section 2, page 17, *infra.*]

SEC. 8. One-half of the penalties recovered for violation of the provisions of this chapter shall accrue to the complainant and the other half thereof to the state.

SEC. 9. The commissioners of inland fisheries may take fish from the fisheries hereinbefore referred to for any purpose connected with fish culture, or for scientific observation. [See section 6, chapter 282, page 18, *infra.*]

SEC. 10. Each of said commissioners may, in the discharge of his duties, enter upon and pass through or over private property without rendering himself liable in an action of trespass.

SEC. 11. The commissioners of inland fisheries shall be allowed their actual disbursements made in carrying into effect the provisions of this chapter.

CHAPTER 138.

GENERAL PROVISIONS FOR THE PROTECTION OF FISHERIES.

SECTION 1. Every person who shall throw into, or deposit in, or cause to be thrown into or to be deposited in any of the public tidewaters of this state or upon the shores of any such tidewaters, any fish offal, or any water impregnated with fish, and every person who shall cause any deleterious substance resulting from the smelting or manufacture of copper, or from other manufactures, or from other sources, which is destructive to fish, or which repels them from coming into the said public waters, or which shall do anything which tends to drive them therefrom, to be emptied, deposited or run into the said public waters, shall forfeit one hundred dollars.

SEC. 2. Every vessel, craft, boat or floating apparatus of any kind whatever, employed in the procuring of fish oil, or in the dressing of bait for the mackerel fisheries, or the dressing of fish for other purposes, in violation of this chapter, shall be liable for any forfeiture and costs resulting from prosecution hereunder, and the same may be attached on the original writ and held as other personal property attached may be held, to secure any judgment which may be recovered in any action brought to enforce any such forfeiture, and any person upon view of any offence in violation of this chapter, may seize and detain any vessel, craft, boat or floating apparatus, the same to be attached for a period not exceeding six hours.

SEC. 3. Every person who shall boil any menhaden fish, or press any such fish for the purpose of extracting oil therefrom, on board of any vessel on any of the public tidewaters, shall be fined not exceeding fifty dollars.

CHAPTER 281.

An Act in amendment of Chapter 134 *of the General Statutes, "Of certain Fisheries."*

(Passed March 12, 1878.)

It is enacted by the General Assembly as follows:

SECTION 1. No person, not a member of the Narragansett tribe of Indians, shall, without the consent of the council of said tribe being first obtained, erect any weir or set or draw any seine or net for the obstructing, catching or hauling of fish, or take any fish with hook and line or in any other manner, in the ponds or other waters within the bounds of the land belonging to said tribe.

SEC. 2. Every person violating the preceding section shall forfeit not less than five nor more than twenty dollars for each offence, to be recovered on complaint made by the commissioner of the Indian tribe, for the benefit of said tribe.

CHAPTER 282.

An Act in amendment of, and in addition to Chapter 137, *Title XVIII., of the General Statutes, "Of the Inland Fisheries."*

(Passed March 11, 1878.)

It is enacted by the General Assembly as follows:

SECTION 1. No person shall take or catch fish of any kind from any of the inland waters of this state set apart by the commissioners of inland fisheries thereof for the cultivation of fish except at such times and in such manner as is hereinafter provided.

SEC. 2. Section 7 of said chapter 137 of the General Statutes of this state is so far amended as to allow the catching of fish through the ice only and with hook and hand line only, in those ponds set apart for the cultivation of black bass during the months of December, January and February of each and every year from the passage of this act, until the expiration of the three years mentioned in section 7 of said chapter.

SEC. 3. (As amended by chapter 539, passed April 19, 1876.) After the expiration of said three years, no black bass shall be taken in any waters of this state, from the first day of March to the fifteenth day of July, and only by hook and line as aforesaid.

SEC. 4. After the expiration of said three years, no fish shall be taken by any person from any waters legally set apart by said commissioners for the cultivation of shad or salmon, or within one mile of the outlet of the streams so set apart except from and after the fifteenth day of April until the fifteenth day of July of each and every year, nor at any time except by hook and hand line, or by not less than three inch mesh nets or seine or seines.

SEC. 5. No person shall take any fish from any of the waters of this state legally set apart for the cultivation of fish during the times allowed to be taken by this act except on Thursdays, Fridays and Saturdays during said term, except the months of December, January and February.

SEC. 6. Nothing in this act shall prevent the commissioners of inland fisheries from taking fish from any of said waters as is now permitted by section 9 of chapter 137 of the General Statutes.

SEC. 7. Any person violating any of the provisions of this act shall be subject to the penalties for catching fish as imposed by section 5 of said chapter 137, of which this act is an amendment.

SEC. 8. All acts and parts of acts inconsistent herewith are hereby repealed.

SEC. 9. This act shall take effect immediately on and after its passage.

CHAPTER 598.

An Act in amendment of Chapter 282 of the Public Laws, entitled "An Act in amendment of and in addition to Chapter 137, Title XVIII. of the General Statutes, 'Of Inland Fisheries.'"

(Passed March 22, 1877.)

It is enacted by the General Assembly as follows:

SECTION 1. Sneach Pond, in the town of Cumberland, is hereby exempted from the operation of chapter 539, "Of inland fisheries."

SEC. 2. This act shall take effect from and after its passage.

NOV 21 1923

State of Rhode Island and Providence Plantations.

29,150

TENTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, A. D. 1881.

PROVIDENCE:
E. L. FREEMAN & CO., PRINTERS TO THE STATE.
1881.

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TENTH ANNUAL REPORT

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JANUARY SESSION, A. D. 1881.

PROVIDENCE:
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1881.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island, January Session, 1881.

The Commissioners of Inland Fisheries beg leave to present their report for the year 1881.

In the report for the year 1880, diagrams were given of the traps set at Seaconnet Point and at the south end of the island of Rhode Island, and also of the location of all the heart nets in Narragansett Bay. It has been thought best not to go to this expense this year. The sets of the traps are about the same from one year to another. The heart nets or pounds vary more in locality, and were all visited and marked on the chart by the commissioners in July and August last. They found forty-one (41) of these pounds in active operation, an increase of ten (10) over the year previous.

The commissioners appointed the same deputies as in 1879, as they supposed they were the persons who were best adapted by their former experience for the office.

The catch of scup in the traps this Spring was not so large as usual, and was estimated to be less by two-thirds than that of 1879, but prices were better, and it is to be supposed most of the fishermen received a fair price for their labor. So far as the trap fishing is concerned the commissioners have seen no reason to change their views given in their last report to your Honorable Body, and respectfully refer to their report for 1880, as it is hardly worth while to go over the matter a second time.

In that report they recommend the line established by Chapter 751, Section 1, (being a line drawn from Narragansett lower pier to Seaconnet Point) be abolished, and the whole coast line of the State be protected; that traps, and above all, heart nets or pounds, should be licensed. Up to the present date no move has been made in the matter by the Honorable General Assembly. The Commissioners of Inland Fisheries are willing and glad to devote a large portion of their time and attention to the bay fisheries, for which they receive no pay, and not any very great measure of thanks, but as a mechanic would find it impossible to perform a piece of work without suitable tools, so they cannot be expected to accomplish much without suitable laws to guide and support them. In this connection they beg to call your most earnest attention to the changes they desire made in Chapter 751, (passed March 26, 1879). These changes have been suggested by the observance of the workings of said Chapter 751 for the past two seasons, and unless such changes are made the commissioners in the future will hesitate to take the responsibility of expending the money which the present law admits in efforts to enforce a law which they feel is inadequate.

Chapter 751 reads as follows:

CHAPTER 751.

An Act in amendment of Chapter 134 of the General Statutes, "Of Certain Fisheries."

(Passed March 26, 1879.)

It is enacted by the General Assembly as follows:

SECTION 1. There shall be, between the first day of May and first day of August in each year, a weekly close-time, extending from Saturday morning at sunrise to Monday morning at sunrise, during which time no fish of any description shall be taken by weirs, traps or similar contrivances, from the waters covered by a line drawn from Seaconnet Point in a westerly course to the Narragansett lower pier, and including all the waters above said line. If there be any weir, trap or other stationary contrivances used for the purpose of catching or obstructing the passage of fish in that part thereof where the fish are usually taken, the netting at the mouth of the same shall be floated to the surface of the water so as to effectually close the mouth thereof during the weekly close-time, so that during said time the fish may have a free, unobstructed passage; and no device shall be placed in any part of said limits which shall tend to hinder such fish from running up the waters of such river. In case the enclosure where the fish are taken is furnished with a board floor, an opening three feet wide shall be made, extending from the floor to the top of the weir, trap or other contrivances: provided, however, that nothing herein shall be so construed as to apply to the shad and herring fisheries in the tributaries of Narragansett Bay.

SEC. 2. The Commissioners of Inland Fisheries shall have a general supervision of all matters relating to the subject contained in the first section of this act, and may make all needful regulations to carry out the provisions described in said section, and shall, from time to time, examine all the weirs, traps or other contrivances, with a view of carrying out such regulations as are most beneficial to the people of the State, and shall prosecute for the violation of such regulations. They may coöperate with the fish commissioners of other states, and shall make an annual report to the General Assembly of their doings, with such facts and suggestions in relation to the object for which they are appointed as they may deem proper. Said commissioners shall be allowed their actual disbursements made in the execution of this act.

SEC. 3. Every person who shall violate any of the regulations made by said Commissioners under the authority of the provisions of the preceding sections of this act, or who, between the days mentioned in said first section, shall set any weir, trap or contrivances, contrary to such provisions, shall upon conviction be fined not exceeding one hundred dollars, or be imprisoned not exceeding three months, or both, in the discretion of the court before whom the offender shall be tried.

SEC. 4. All acts and parts of acts inconsistent with the provisions of this act are repealed.

The changes we desire are the following, and in this connection we would say that they have been most carefully drawn up by our counsel, Mr. Francis W. Miner, whose ability as a lawyer is unquestioned, and whose interest in the cause is very great.

An act in amendment of Chapter 751, " Of Certain Fisheries.

SECTION 1. Of said chapter in the fourth line, after the words "similar contrivances," striking out the words "from the waters covered by a line drawn from Seaconnet Point in a westerly course to the Narragansett lower pier, and including all the waters above said line," and inserting in their place the following words; "the whole of the waters of the coast line of the State and Narragansett Bay."

SEC. 2. No person shall at any time use or suffer to be used by any person, any weirs, traps, heart nets, or similar fixed contrivances used for the purpose of catching and obstructing the passage of fish within the waters of this State unless as is hereinafter provided.

SEC. 3. The Commissioners of Inland Fisheries may grant, or refuse to grant, licenses to such number and to so many citizens *resident* within this state to use weirs, traps, heart nets and similar stationary contrivances for the purpose of catching fish within the waters of this State, as they may think proper. Each license so granted shall be taken out in the name of the owner of said weir, trap, or heart net, or *other* stationary contrivance, and shall continue in full force for one year from the date of the license, unless revoked as hereinafter provided.

Before granting license to any person under the provisions of this act said Commissioners shall give notice, in such manner as they may direct, of the name of the applicant for said license and the particular location for which the license is requested. And before any license shall be issued under the provisions of this act, the person applying therefor shall give bond to the *State Treasurer* in the penal sum of $500, with at least two sureties satisfactory to the said Commissioners of Inland Fisheries, conditioned that he will not violate any of the provisions of this act, and he shall also pay to the said Commissioners of Inland Fisheries the sum of $25, to be paid to the General Treasurer for the use of the State.

SEC. 4. If any person shall be convicted of the violation of any of the provisions of this act, his bond shall be put in suit by the State Treasurer, and by due process of law the penal sum of said bond be recovered for the use of the State.

SEC. 5. Every person licensed under this act shall, on or before the 1st day of November in each and every year, make a sworn return to the Commissioners of Inland Fisheries of the amount of catch and the prices realized for the same, and blank forms for such returns shall be issued by said Commissioners and sent to each and every licensed person, and no new license shall be issued to any person neglecting or refusing to make such return.

SEC. 6. The Commissioners and their deputies shall have free access to the said weirs, traps, heart nets and other fixed contrivances, at any and all times, for the purpose of examining the catch, etc.

SEC. 7. Purse seining and gill netting is hereby prohibited in Narragansett Bay and its tributaries north of a line drawn from Pojac Point to Warwick Light, from Warwick Light to North Point on Prudence Island, from North Point to Popasquash Point, from Popasquash Point to Bristol Ferry in Bristol County.

SEC. 8. If any person shall violate any of the provisions of this act he shall, upon conviction, be fined fifty dollars.

SEC. 9. Any defects of form in any active complaint and warrant, indictment, information or other proceeding may be amended by the court before whom the action, complaint and warrant, indictment, information or other proceeding is brought.

SEC. 10. Whenever any complaint or other proceeding under this act shall be made by any Commissioner of Inland Fisheries against any person violating any of the provisions of this act, such Commissioner shall not be required to give surety for costs, but be liable in his individual capacity therefor. And the jurisdiction of justice courts over crimes and offences committed under this act may be exercised by the justice court of any town adjoining the public waters of this State.

SEC. 11. Nothing in this act to be construed as applying to gill nets or fyke nets in any of the waters controlled by this State.

Our reasons for asking for these changes are as follows, section by section:

SECTION 1.—The line drawn from Narragansett lower pier to Seaconnet Point is unjust and arbitrary, for the reason that it curtails the operations of trappers at the south end of the island of Rhode Island and at Seaconnet Point, and permits unlimited fishing from said Narragansett lower pier south around Point Judith, and from that point westward to Watch Hill, a distance of twenty-five miles, and in our opinion that portion of our coast requires protection as much, and perhaps more, than any other. (See our report for last year.)

SECTION 2.—Requires no comment.

SECTION 3.—We desire a system of licenses in order that better supervision may be had of our coast and bay fisheries; that proper statistics may be obtained as to their value; and that a small sum be paid by such parties as are engaged in the business to assist in paying the expense of such supervision and collection of such statistics.

SECTION 4.—This to render licensed persons more cautious than they would otherwise be, as their bondsmen would take an interest in their conforming to the requirements of the law.

SECTION 5.—That complete and thorough statistics may be had of the catch of fish and value thereof in our waters.

SECTION 6.—To save expense to the State, and labor and trouble to the Commissioners and their deputies.

SECTION 7.—This is, in our opinion, a very necessary addition to our fishery laws. In the summer months the menhaden come into Narragansett Bay for the purpose of depositing their spawn, and gradually work their way up to the head waters thereof. Seekonk River was a famous spawning ground for them in past years. The bluefish follow them, for the menhaden is their chief food. Fleets of sailing vessels and steamers follow them, and hardly any are left to propagate. If the head of our bay, from these points, could be set apart to protect them, at no possible expense, an abundant supply of these very important fish would be secured to us, and the fishermen that make them their prey would reap in the future an abundant reward for their forbearance.

SECTION 8.—That violators of the law may be made to pay a severe penalty.

SECTION 9.—To save expense to the State in event of prosecution.

SECTION 10.—Because gill netting and fyke netting do less harm to our bay fisheries than any other ways of fishing where nets are employed. The gill nets only take fish of a certain size, and the fykes are used almost entirely in the spring for the catching of flounders or flat fish.

The abundance of fish in our bay the past season has been a cause of remark and congratulation on all sides. Scup of large size have been plentiful; tautog or black fish, also, and the quantity of young blue fish and squitague taken at the head of the bay, and even at the head of navigation on the Seekonk River, at Pawtucket, has been entirely without precedent, affording enjoyment and profit to a very large number of the good people of this State. This may be attributed to two causes or a combination of two causes. First, the weekly close-time as provided by chapter 751, section 1; and, second, an exceptionally abundant season for these sorts of fish, due to favorable circumstances at the spawning season, etc.

The advocates of the close-time law have every reason to congratulate themselves on its success the past season, but at the same time they should be prepared not to be discouraged in the event of a scarcity of fish in years yet to come.

During the past summer Prof. Spencer F. Baird, United States Commissioner spent the whole of his very valuable time in Newport, himself and his force of trained assistants studying the fisheries of Narragansett Bay and vicinity. The people of the State of Rhode Island are to be congratulated that this, the foremost man in the world in knowledge of fish and fisheries both practically and scientifically, has been among us to tell us what is best to do. When he speaks, it will be well for us to listen. He proposes to return again next season and continue his observations.

When a law is enacted to provide for the general public good, and encroaches, as in all cases it must, on the interests and privileges of a small class, it is always the case that such law, beneficial as it may be for the general public, is defied by some individuals of the class who imagine themselves injured by it. Mr. King, of Jamestown, having disregarded all due warnings was arrested and brought before Justice Tillinghast at East Greenwich for violation of the weekly close-time from Saturday morning at sunrise to Monday morning at sunrise from May 1st to August 1st. Two heart nets, or pounds were maintained by him in Dutch Island harbor. It was thought best to bring an action against him in East Greenwich before a justice of the peace, and that necessitated his arrest by a sheriff of that county. To accomplish this his arrest had to be made *on the waters of the bay*. Mr. Burlingame, the very efficient sheriff of that county took the job in hand. One of the Commissioners of Inland Fisheries was obliged to go to Greenwich and give bond. This was done. The case was tried before Mr. Justice Tillinghast, and held for two weeks for advisement. He was then bound over to appear before the Supreme Court of Kent County at the March term. The case is therefore in the hands of the Attorney General of the State.

In prosecuting this case to the end, it is the desire of the commissioners to test the working of the law, and endeavor to enforce the same as in duty bound. We find the amendments suggested to be very much needed. (See Sections 9 and 10 in amendment.)

To show the workings, cost, catch and profits of trap fishing, we submit the following statistics collected by our deputy, at Newport the past summer, and his remarks thereon.

(Many barrels of valuable fish taken in the heart nets set in the vicinity of Wickford, and owned by Mr. Farnum, were used as manure the past season.)

Amount of fish taken from trap at Boat House Point, Newport, R. I., and prices realized for same during the season of 1880. Taken from clerk's books:

1880.

April 23.	14½	barrels of	Scup at	$4.00	$58 00
26.	36½	"	"	4.00	146 00
26.	32½	"	"	3.50	113 87
26.	1½	"	Striped Bass,	5.00	7 50
27.	17	"	Scup,	3.60	59 50
28.	1½	"	Striped Bass.	5.00	7 50
29.	26½	"	Scup,	3.50	92 87

1880.						
May	5.	4½	barrels	Rock Bass,	3.00	$13 60
	10.	37½	"	Scup,	.75	28 12
	10.	2½	"	Rock Bass,	1.87	4 67
	11.	39½	"	Scup,	.75	29 62
	11.	3½	"	Rock Bass,	.75	2 62
	11.	4	"	Weak Fish,	.75	3 00
	12.	13	"	Scup,	.75	9 75
	13.	7½	"	"	1.00	7 50
	13.	½	"	Striped Bass,	4.00	2 00
	14.	16	"	Scup,	1.50	24 00
	15.	13½	"	"	1.50	20 25
	17.	44	"	"	2.00	88 00
	18.	45	"	"	2.00	90 00
	18.	2½	"	Striped Bass,	5.00	12 50
	19.	21½	"	Scup,	2.00	43 00
	21.	21½	"	"	2.00	43 00
	22.	27	"	"	2.00	54 00
	23.	39½	"	"	3.00	118 50
	23.	3	"	Striped Bass,	6.00	18 00
	24.	2	"	" "	6.00	12 00
	24.	1½	"	Scup,	2.00	3 00
	24.	22	"	"	3.00	66 00
	25.	3	"	Striped Bass,	6.00	18 00
	26.	3½	"	Flounders,	1.50	5 25

Sold to peddlers at trap $98.84 during catch.

You will observe that the total amount of catch is $1,300.46. One-third of this amount goes for the use of boats and trap. There was one boat twenty-two feet long worth about $20; two small boats fourteen feet long, worth about $18 each; $56 for boats. The trap was made out of old seines purchased from mackerel catchers, and was not worth and did not cost over $100; whole cost $156. One-third of $1,300.46 is equal to $433.48, the sum the owner of the trap recovered. There were six men in gang fishing. The remaining two-thirds were divided among them, each man receiving $144.42 for his labor.

You will also notice that there were 9½ barrels of striped bass taken, picked out from the scup and sold separate. These bass were all *small*, running from ½ pound up to 3 and 4 pounds each. The small bass are mixed in and taken with the scup, and as a usual thing sold with the scup, but when very plenty are picked out and sold separate on account of their value. The word scup is used in this account because they will exceed in quantities any other kind of fish taken in traps, there being as a usual thing a general assortment of all kinds of fish known in our waters. No one need ask what has become of the splendid bass-fishing for which the rocks at Newport were noted in years past, when this wholesale destruction of the small fish is being carried on. Taking this trap as an average trap (it was the smallest along the shore), you can conceive of the great amount of fish destroyed—I mean small fish. During the season the trap at Price's Neck must have taken three times this amount of fish, being the best set along the shore. As to fish in the bay the past season it is the general remark that for years they have not been so plenty. Large scup have been taken at Patience and Hope Islands, weighing nearly a pound each, and fishermen anchoring anywhere in the bay, in five feet of water, have found all the small scup they wanted. Captain Place can give you the names of fishermen who can prove this.

In September we sent Captain Place with Mr. Ludwig Rumlien, assistant of the United States Fish Commissioner, and special agent 10th census, to collect names of and the number of fishermen, trappers, purse-seiners, sweep-seiners, owners of pound or heart nets, and hand-line fishermen in Rhode Island.

Capt. Place reports as follows:

MENHADEN FISHERIES AND OIL WORKS AS COLLECTED BY LUDWIG RUMLIEN, SPECIAL AGENT 10TH CENSUS.

Narragansett Oil Works, Daniel Church & Company.

Capital invested in oil works	$35,000 00
In seven steamers with outfits	77,000 00
In sailing vessels	6,000 00
Interest in four traps at Sachuest	4,000 00
Interest in two traps at Seaconnet	2,000 00
	$124,000 00

Fish taken, 210,000 in 1879. Manufactured 165,000 barrels of fish; producing 4,900 barrels of oil and 7,000 tons of guano. Employing 75 men about the works; 120 men fishing in their employ.

William Brightman's Oil Works, Tiverton, R. I.

Capital invested in works	$18,000 00
One steamer	8,000 00
Two sailing vessels	3,500 00
	$29,500 00

Manufactured 42,000 barrels of fish; produced 50,000 gallons of oil and 1,260 tons of guano; 17 men employed about the works; 27 men fishing.

James Manchester, Tiverton.

Caught 4,000 barrels of fish; produced 5,000 gallons of oil and 120 tons of guano; one sailing vessel, value $600; employed eight men at the works and eight men fishing.

Isaac Brown, Tiverton.

Produced 32,000 gallons of oil and 750 tons of guano; capital invested $10,000; four vessels, $3,800; 17 men employed in the works; 32 men fishing.

Charles Cook, Tiverton Four Corners.

Manufactured 3,000 barrels of fish; produced 3,500 gallons of oil, 90 tons of guano; one steamer, value $6,000; employed 5 men in the works, 10 men fishing.

C. Otis Wilcox, Tiverton Four Corners.

Caught and manufactured 6,000 barrels of fish; producing 7,500 gallons of oil, 180 tons of guano; one steamer and outfits, value $4,000; employed 6 men in the works, 9 men fishing.

(This is an estimation by W.D. Wilcox.)

Atlantic Works, below Bristol Ferry. No report. Officers of the company in Boston, Mass.

Oil works at the south end of Prudence Island come in with Job Wilson's works at Cole's River, Mass.

Remarks on East River (Seaconnet River) *from Stone Bridge to Seaconnet Point.*— I find a great deal of difficulty in getting at the number of men that fish in this river by other methods than traps and seines. Great complaint is made by summer visitors at the scarcity of fish as compared to former years. They attribute it to spring trapping and heart seines during the summer season.

East Greenwich.—Fifteen men in this place are engaged in fishing throughout the year; ten of these fish by all methods, in February they set fyke nets for flat fish, in April and May by hand line and shore seines, in July and the rest of the season, gill nets; two of them maintained a pound trap or heart net in Pine Hill Bay (Prudence Island) the past season. E. Mitchell, of this place, says that he has followed fishing for a living for twenty years—his father was a fisherman before him—and that for several years past the fishing has fallen off to such an extent that it has not been profitable in Greenwich Bay. The value of the fish taken would not amount, he thinks, to $2,000 a year. He attributes the scarcity to impurity of the water. He thinks *young fish* are more numerous this year than he ever saw them before.

Apponaug.—Fifteen boats and twenty-five men employed in this place fishing. Method, shore seines, hand line, gill nets and eel pots. The value of catch they estimate at $1,500 for several past years. I am told that fishing has fallen of more than one-half what it was ten years ago. They attribute the cause to trapping and heart nets in the main bay. They also report that the water is impure at this place and has killed out the clams for more than a mile from the bridge. Shad and herring formerly came up there, none in later years. Seven sail-boats, owned in this place and Coweset, take parties fishing in the summer.

Warwick Cove.—Six boats and nine men. Method, hand line, shore seine and gill-nets; value of catch the past year $500. They say the fishing has fallen off two-thirds as compared to ten years ago, and attribute it to heart nets and trapping.

Warwick Neck.—Two boats, eight men. Method, shore seines.

Mill Cove, Warwick.—Four boats, seven men. Method, hand line, shore seines and gill-nets; value of catch, $800. They report an abundance of *small* fish of this year's growth. They report the same scarcity as the others in regard to former years, and lay it to heart nets and trapping.

Wickford.—Ten men in this place eke out a living by hand line fishing, lobster pots and eel pots. H. Farnum, pharmacist of Wickford, has two heart nets, worked by J. O. Lewis on shares. Mr. Farnum says he invested $300 in putting out two heart nets this Spring, and let them out to J. O. Lewis on shares, he receiving one-third of gross amount of catch. Up to date, (Sept. 10th) he had received $160. Reliable information gives thirty men in the fishing business in this place.

Dutch Island Harbor.—There are eleven men, all of them named King, who follow fishing for a business. Two of them are hand-liners and lobster catchers, two hand-liners and pilots, and the other seven, trappers. It is impossible to get a correct and truthful report from any of them. We interviewed five of them, and could get no correct value of fish taken by them yearly.

Saunders' Town, (opposite Dutch Island.)—Three men and three heart nets. Lobster pots and cod-fishing in winter.

Bristol.—Twelve men follow hand line fishing. Two men have four heart nets in the vicinity, one at Mount Cove, one at Hog Island, one at the ferry, one in the harbor. They report their catch at about 75,000 pounds for the year 1879. The hand line fishermen report slim fishing the past few years at this place.

Newport.—I have found that there are about one hundred men who follow fishing for a living here; twenty-five trappers and about seventy-five hand-liners, also twenty boatmen who take parties fishing. I have interviewed very many of them, and they all tell the same story, if they have no interest in traps or heart nets, and all say that these have injured and almost ruined the fishing in the bay. I have the names of seventy men who fish with hand lines most of the year. James Holt and William Holt say they have been fishermen for more than twenty years. The value of fish taken by them each year would not exceed $200. They have to rely on lobster catching for a living. They think that their catch is more than an average of hand line fishermen, and includes cod fishing in the fall and winter months.

Twenty-five men are interested in heart nets and traps; (the Captain gives a list of their names and location of the heart nets.—*Commissioner.*) all of whom were very reluctant to give any information about their business and also refused Mr. Rumlein, who had to adopt other methods. The hand line fishermen were always ready to give any information in their power, and all agreed that the heart nets were profitable to those engaged in the business. The boatmen also were very ready. Their interest is involved in the matter, as they rely for their support in part in taking parties fishing in the summer months.

Mr. Alger, boat builder on Long Wharf for the past thirty years, gave a great deal of information as to the fisheries, past and present. He personally knows almost all the fishermen, hand-liners and trappers. He is related to two (trappers) who only fish four months in the year, and he estimates their profits at $800, and they make more than he does working all the time. His estimate of the value of the catch of the hand line fishermen, with lobster pots and cod-fishing in the fall and winter months is at about $250 to $300, in the past five years. He says there are more than twice the number of boats and men engaged in the fisheries than there were fifteen years since, with a falling off of at fifty per cent. of the catch, but prices in the meantime have doubled, in fish and lobsters.

I suppose Mr. Rumlein will get at the value of the catch of fish in our bay with some accuracy, but it will require time and patience to accomplish it. Some of the trappers refused to give him any information fearing the *State* would take advantage of it to their detriment.

Warren.—There are ten or twelve men that fish for shad and herring in the spring. Method of capture, traps and heart nets. They estimate the value of shad caught the past season at $2,100. Ten men follow hand line fishing exclusively.

Nayatt Point.—Ten men follow fishing here with hand lines in spring and fall. One shore seine, not used however for several years.

Pawtuxet.—Two shore-seiners and two hand-liners who make it their business; several others who fish occasionally.

Providence.—There are no men in Providence, or but a very few, who depend upon fishing for a living the year round. Large numbers come down from the city in the spring and fall and fish with hand lines in the vicinity of Nayatt Point, Warwick Neck and the Islands.

This shows that there is invested in this State by parties *residing* in the State, one hundred and seventy-seven thousand three hundred dollars in works, steamers, boats, etc., giving employment to three hundred and thirty-four men in the menhaden fishery; two hundred and forty-six men who depend upon fishing for their support the year through, of whom forty-three are interested in heart nets. Exactly why this small number of individuals should be allowed, year after year, to deplete and almost ruin the fisheries in our splendid bay, we fail to see, and in our capacity as commissioners and faithful servants to our trust, and to the people of the State of Rhode Island who have honored us with our office, we most respectfully and earnestly beg that the Honorable General Assembly will enact such additions to our fishery laws as we have suggested.

We find there are a number of individuals, non-residents of this State, who carry on the manufacture of fish oil and guano, and heart seining. to say nothing of lobster catchers. All this may be remedied by the enactment of Section 3 of our proposed amendment to Chapter 751, save as regards to lobster-fisheries; Section 8 of Chapter 134 will do that very thoroughly if properly enforced.

We most earnestly desire to call the attention of your Honorable Body to the very important question of the lobster fishery in our waters. Maine, Massachusetts and New York have seen fit to protect themselves, and it is more than time the State of Rhode Island followed their example. The following letter was received from Prof. Baird the past summer:

"I enclose you herewith a letter just received from Mr. Wilcox, the Chairman of the Boston Fish Bureau. Will it not be very desirable to have Rhode Island enact a law in regard to the limitations of the size, of lobsters, simply doing what Maine, Massachusetts and New York have done. Their standard is 11½ inches. You might suggest the same for Rhode Island."

The letter referred to from Mr. Wilcox says:

"After leaving you this noon, I took a ramble around the fish stands [at Newport] and was reminded I was out of Massachusetts by seeing the fishermen bring in lobsters not any over six or eight inches long, and they called them large. I presume Rhode Island has no law as to size, but I am sure they need one, for such small specimens of lobsters I have never seen in any market."

The lobster law of Massachusetts is as follows:

SECTION 1. Whoever sells, or offers for sale, or has in his possession with intent to sell, either directly or indirectly, any lobsters less than ten and one-half inches in length, measuring from one extreme of the body to the other, exclusive of claws or feelers, shall forfeit for every such lobster five dollars.

SEC. 2. All forfeitures accruing under this act shall be paid one-half to the person making the complaint, and one-half to the city or town where the offence is committed.

SEC. 3. This act shall take effect on the first day of May, 1874.

This act is very well as far as it goes, but does not cover the whole ground by any means. The capture of small lobsters has gone on in Rhode Island since the first lobster pot was put in Rhode Island waters, the larger ones sent to market, and the smaller used for bait for black fish. Let us see what the Rhode Island law amounts to, Sec. 8 of Chapter 134: "If any person not at the time an inhabitant of this State shall set, or keep, or cause to be set or kept, within any of the waters, or upon or within three miles of any shore of this State more than two pots or nets for the catching of lobsters at any one time, he shall forfeit twenty dollars for each offence." Sec. 9: "If any person shall lift or raise any pot or net set for the catching of lobsters, without the permission of the owner thereof, he shall forfeit ten dollars."

It would appear from this that the laws of the State of Rhode Island attempt to protect lobster fishermen, but do nothing toward protecting the unfortunate lobsters, which are vastly more in need of encouragement.

Complaints have been made in past years to the Commissioners (before any supervision of the bay fisheries was given to them) that many parties from Massachusetts were setting hundreds of lobster pots in Rhode Island waters. All we could do was to show them the law, and advise them to protect themselves. This, so far as we know, has never been attempted. Now our lobster fishery is a very valuable one. Very many men eke out a living with their lobster pots, and all know the luxury of an abundance of fresh and cheap lobsters in our cities. For a number of years past the catch of lobsters has been steadily decreasing, not as to numbers, but as to size. "All is fish that comes to the net" is the rule with lobster catchers. Those that are of a size fit to send to market, from half a pound upwards, are sent, the balance, from five to six or seven inches in length, are sold for bait for tautog fishing, save a few that go to those most delicate palates that delight in "chicken lobsters."

We most respectfully advise and request your Honorable Body to at once pass a law for the protection of lobsters, as follows:

An act entitled an act for the protection of Lobsters and Lobster Fisheries in the State of Rhode Island.

SECTION 1. Whoever sells, or offers for sale, or has in his or her possession with intent to sell, either directly or indirectly, any lobsters less than twelve inches in length, measuring from one extreme of the body to the other, exclusive of claws and feelers, shall forfeit for every such lobster five dollars.

SEC. 2. All forfeitures accruing under this act shall be paid, one-half to the person making the complaint and one-half to the city or town where the offence is committed.

It would be admirable if a provision could be made forbidding the sale of female lobsters loaded with spawn. August seems to be the month in which the bulk of lobsters are so loaded, although they seem to be taken at all times of the year with spawn. It is a well known fact, of course, that the female passes her spawn and retains it under her tail for a period, probably until it is hatched. Every female destroyed at this time represents the destruction of tens of thousands of young. Could the catchers of lobsters, who are comparatively a very small factor of the general public, be made to see what an increase it would give to their annual profits if these spawners were returned to their element, and time given them to hatch their young, and these young not taken until they are of a size to make them of some value in the markets, we feel sure they would be the first of all to endorse such a law as we suggest.

Lobsters are always in great demand. If not sold fresh they are canned and sent to the interior of the continent where the fresh lobster is never seen. So far as the limit of size is concerned we are well assured the law will be most popular. All persons we have interviewed on the subject, catchers, sellers and consumers, are unanimous that such a law is needed, and we feel safe in saying that it will meet with entire acceptance.

The State of Rhode Island is at present the market for under-sized lobsters from Massachusetts. They are sent here in barrels, the catchers on the Massachusetts coast and dealers in Boston, knowing that it would be unsafe to offer them for sale in Massachusetts, send them to us and we get the full benefit of such poor and illegal supply. The difference in length of lobsters makes a vast difference as to their weight, as follows:

Fifteen inches	4	pounds.	These weights are from boiled lobsters, and not in especially good order, but selected for their weight from a large number.
Fourteen "	2¾	"	
Thirteen "	2½	"	
Twelve "	2¼	"	
Eleven "	1¾	"	
Ten "	1¼	"	

In boiling they shrink about twenty per cent., on an average, and the better their condition, the less the shrinkage. Poor condition means, probably shedding, which is supposed to occur once a year.

This is "not proven." It may be oftener, and very likely is, at least among the younger growth. How fast they grow, and what a very young lobster is like is at present not known to us; a system of experiments, as far as we know, has never been attempted in America. It must be elaborate and expensive, and well worthy the attention of the United States Government. To show the extent and value of the lobster fishery in Rhode Island, we submit the following from the principal dealers in Providence: One firm in this city handled, last year, about 143,750 pounds, the bulk of which came in the summer months from Rhode Island waters. Another firm received from E. C. Smith, of Newport, the past year, 40,672 pounds, and Mr. Smith handled 58,764 pounds the past season, all from Rhode Island waters. This represents a value of over $20,000. It would seem that this subject is well worthy the attention of the Legislature of this State, and we ask your immediate action in the matter.

INLAND FISHERIES.

We have to report the stocking of the Georgiaville Reservoir with black bass the past summer, making twenty-seven public waters so stocked during the past ten years. Black bass are now a Rhode Island fish, and afford much satisfaction to those of our citizens whose pleasure it is to "go a fishing." The greatest recorded weight as yet taken in our waters is 5½ pounds.

We received in November from Prof. Baird a consignment of two hundred carp. These we distributed to the best of our ability to twelve parties who had made application for them. The requirements of carp are still water of moderate depth, muddy bottom and plenty of water plants, and an absence of other fish that destroy the spawn and young. The carp is as a general thing a vegetable feeder, but does at times eat its own eggs. To make carp culture profitable a series of ponds should be maintained. We are promised a larger number in the spring, and shall take pleasure in distributing to all applicants who may have suitable accommodations for them.

A very large consignment of shad is promised us from the government hatching the coming summer, which will be very valuable and suitably disposed of. We would respectfully request that an appropriation of $1,000 be made to allow us to meet any expenses demanded. No appropriation has been made for the past few years, and our funds are reduced to a very low ebb. We append our financial statement for the past year, showing our expenditures for the Inland Fisheries, and for the supervision of the coast and bay department.

AFFRED A. REED,	*Commissioners*
JOHN H. BARDEN,	*of*
NEWTON DEXTER,	*Inland Fisheries.*

State of Rhode Island in account with Commissioners on Inland Fisheries, for account Inland Fisheries:

1879.			
July 31.	To amount paid Robert J. Holmes for stocking Georgiaville pond with 26 black bass	$62 00	
	To amount paid express on bass to Georgiaville pond	4 00	
	“ “ “ Billings Bros. for team for Commissioners	6 00	
	To amount paid J. A. & R. A. Reid for 12 cloth posters for Georgiaville pond stating the law on fishing in the same	2 25	
Oct. 31.	To amount paid Robert R. Holmes for distributing carp	16 00	
	To amount paid telegrams to Washington, etc., about carp	4 00	
Nov. 30.	To amount paid traveling expenses Newton Dexter, Commissioner	10 00	
1881.			
Jan. 31.	To amount paid traveling expenses J. H. Barden, Commissioner	8 56	
			$112 81
	To balance of appropriation on hand this day		130 01
			$242 82

1879.				
July	31.	By amount of appropriation on hand this day......		242 82
1881.				
Feb.		By balance brought forward on hand this day.....	$130 01	

JOHN H. BARDEN, } *Commissioners*
NEWTON DEXTER, } *on*
ALFRED A. REED, } *Inland Fisheries.*

PROVIDENCE, February, 1881.

State of Rhode Island in account with the Commissioners of Inland Fisheries, for account of Bay Fisheries:

1880.			
Jan.	31.	To amount paid W. D. Wilcox, Deputy, for expenses to Newport for evidence....................	$5 00
May	31.	To amount paid J. A. & R. A. Reid for printing 100 letter circulars of regulations..................	2 25
		To amount paid for postage..........................	1 12
		" " " R. M. Bliss use of boat and watching traps in bay..................................	21 00
June	26.	To amount paid Knowles, Anthony & Danielson, printing regulations..........................	7 87
		To amount paid Mercury office, printing regulations	10 00
		" " " telegram..........................	75
July	31.	" " " Continental Steamboat Co., for tug Reliance for Commissioners to inspect bay for traps..	50 00
		To amount paid expense of Commissioners inspecting bay for traps..................................	30 00
Aug.	4.	To amount paid W. D. Wilcox, Deputy, for services and expenses in enforcing the regulations of trap fishing at Warwick..........................	256 35
		To amount paid Samuel Place, Deputy, services, etc., etc., at Newport..........................	232 00
		To amount paid S. H. Vaughn, Deputy, services, etc., etc., at Wickford..........................	69 00
Dec.	18.	To amount paid Geo. Burlingame, Sheriff, for arresting John B. King, at Dutch Island, obtaining proof, etc..................................	75 00
	28.	To amount paid Knowles, Anthony & Danielson, advertising..................................	3 00
1881.			
Jan.	17.	To amount paid Samuel Place, Deputy at Newport, services and expenses..........................	70 00

1881.			
Jan. 20.	To amount paid Miner & Roelker, legal services, convicting J. B. King, etc., etc	150 00	
Feb. 1.	To amount paid Newton Dexter and John H. Barden, traveling expenses	15 00	
			$998 34
	Cr.		
Feb. 21.	By amount received to settle account		998 34

JOHN H. BARDEN, } *Commissioners*
NEWTON DEXTER, } *on*
ALFRED A. REED, } *Inland Fisheries.*

PROVIDENCE, February, 1881.

APPENDIX A.

LIST OF FISH COMMISSIONERS.

Canada.

W. F. Whitcher	Ottawa, Ontario.
S. Wilmot, Supt. of Fisheries	Newcastle, Ontario.

New Brunswick.

W. H. Venning, Inspector of Fisheries	St. John.

Nova Scotia.

W. H. Rogers, Inspector of Fisheries	Amherst.

Prince Edward's Island.

J. H. Dewar, Inspector of Fisheries	Alberton.

British Columbia.

A. C. Anderson, Inspector of Fisheries	Victoria.

United States.

Prof. Spencer F. Baird	Washington, D.C.

Alabama.

This State had a Commission last year, but we have been unable to get a reply to letters addressed to them.

California.

S. R. Thockmorton	San Francisco.
B. B. Redding	“ “
J. D. Farwell	Niles, Alameda Co.

Colorado.

W. E. Sisty	Brookvale.

Connecticut.

W. M. Hudson	Hartford.
Robert G. Pike	Middletown.
G. N. Woodruff	Sherman.

Georgia.

Thomas P. James	Atlanta.

(Commissioner of Agriculture, and *ex-officio* of Fisheries.)

Illinois.

N. K. Fairbank	Chicago.
S. P. Bartlett	Quincy.

(Mr. J. Smith Briggs, of Kankalee, was on the board, but his term has expired and no appointment has been made to date.)

Iowa.

B. F. Shaw	Anamosa.

Kansas.

D. B. Long	Ellsworth.

Kentucky.

Hon. John A. Steele	Midway.
Dr. Wm. Van Antwerp	Mt. Sterling.
A. H. Goble	Catlettsburg.
Hon. C. J. Walton	Mumfordville.
Dr. S. W. Coombs	Bowling Green.
John B. Walker	Madisonville.
Wm. Griffith, President	Louisville.
W. C. Price	Danville.
P. H. Darby	Princeton.
Hon. J. M. Chambers	Independence, Kenton Co.

Maine.

E. M. Stillwell	Bangor.
Henry O. Stanley	Dixfield.

(Commissioners of Fisheries and Game.)

Maryland.

T. B. Ferguson (Address 1,327 M Street, Washington, D. C.	Baltimore.
Thomas Hughlett	Easton.

Massachusetts.

Theodore Lyman	Brookline.
E. A. Brackett	Winchester.
Asa French	Boston.

Michigan.

Eli R. Miller	Richland.
A. J. Kellogg	Detroit.
Dr. J. C. Parker	Grand Rapids.

Minnesota.

Daniel Cameron	La Crescent.
Wm. W. Sweeney, M. D.	Red Wing.
R. Ormsby Sweeny, Chairman	St. Paul.

Missouri.

Hon. Silas Woodson, Chairman	St. Joseph.
Hon. H. Clay Ewing	Jefferson City.
John Reid	Lexington.

Nebraska.

R. R. Livingston	Plattsmouth.
H. S. Kaley	Red Cloud.
W. L. May	Fremont.

Nevada.

H. G. Parker	Carson City.

New Hampshire.

Samuel Webber	Manchester.
Luther Hayes	South Milton.
Albina H. Powers	Plymouth.

New Jersey.

Dr. B. P. Howell	Woodbury.
E. J. Anderson	Trenton.
Theo. Morford	Newton.

New York.

Hon. R. B. Roosevelt, 76 Chambers Street	New York.
Edward M. Smith	Rochester.
Richard U. Sherman	New Hartford, Oneida Co.
Eugene G. Blackford, 809 Bedford Avenue	Brooklyn.

North Carolina.

P. M. Wilson, (Acting Com.)	Raleigh.

Ohio.

J. G. Fisher, President	Coshocton.
R. Cummings, Treasurer	Toledo.
L. A. Harris, Secretary	Cincinnati.

Pennsylvania.

H. J. Reeder	Easton.
B. L. Hewitt	Holidaysburg.
James Duffy	Marietta.
John Hummel	Selingsgrove.
Robert Dalzell	Pittsburg.
G. M. Miller	Wilkesbarre.

Rhode Island.

Newton Dexter	Providence.
John H. Barden	Rockland.
Alfred A. Reed	Providence.

South Carolina.

A. P. Butler	Columbia.

(Commissioner of Agriculture and *ex-officio* Commissioner of Fisheries.)

Tennessee.

W. W. McDowell	Memphis.
George F. Akers	Nashville.
Hon. W. T. Turley	Knoxville.

Texas.

J. H. Dinkins	Austin.

Utah.

Prof. J. L. Barfoot (Curator Deseret Museum).	Salt Lake City.

Vermont.

Dr. M. Goldsmith	Rutland.
Charles Barrett	Grafton.

Virginia.

M. McDonald	Lexington.

West Virginia.

Henry B. Miller	Wheeling.
C. S. White	Romney.
N. M. Lowry	Hinton.

Wisconsin.

Gov. Wm. E. Smith, (*ex-officio*)	Madison.
Philo Dunning, Bresident	"
J. V. Jones	Oshkosh.
C. L. Valentine, (Secretary and Treasurer)	Janesville.
Mark Douglas	Melrose, Jackson Co.
John F. Antisdel	Milwaukee.
Christopher Hutchinson	Beetown, Grant Co.

APPENDIX B.

We append the following communication from Prof. Richard Rathbun, sent us by the kindness of Prof. S. F. Baird. It arrived after our report was in the printer's hands, and we are only able to give it here without comment.

THE HOMARUS AMERICANUS.

A few notes on the Size, Habits, Spawning, etc., of the American Lobster, (Homarus Americanus,) prepared for Newton Dexter, Esq., Fish Commissioner of Rhode Island, by Richard Rathbun, Assistant, in charge of Department of Invertebrates, United States National Museum.

We have at present very little reliable data concerning the spawning and other habits of the American lobster. Only two or three reports on the subject have as yet been published, and none of these cover the ground referred to in your letter of inquiry. They are, however, quoted at the end of this paper.

As a special agent of the United States Census, detailed to work up the edible marine invertebrates of our coast, I sent out some time ago a quantity of circulars to the principal lobster dealers and catchers, requesting information on many matters of interest. Some of the replies are undoubtedly trustworthy, and from these I have hastily put together the following notes in reply to the subjects you suggest. They do not cover all the ground, but may possibly assist you in the good work of aiding to protect our lobster, which is fast becoming exhausted along a large part of our coast.

My census report, which must be ready by June, will be as complete as possible, and by that time I hope to have more data that will be of service to you, and if so, I will gladly furnish it.

SIZE.

The average size of lobsters brought to three of the principal markets, as given by reliable dealers, is as follows, the length being exclusive of the big claws:

	Length.	Weight.
Boston	11 to 11½ inches.	1½ to 1¾ pounds.
New Haven	10½ "	
New York	10½ to 15 "	2½ pounds.

Mr. Fuller, of New Haven, says that the average size brought there now is about ten and one-half inches against thirteen inches twenty years ago.

The information received from catchers on the same subject varies, and cannot be as reliable as the above. Along the southern New England coast, however, most catchers agree in giving the average size of those caught and disposed of as from about ten and one-half to twelve inches. But one or two said as low as eight inches. On the coast of Maine, the average is rather higher, but not much.

As to whether the lobster had decreased in size or not, the universal answer was "yes"; but very few gave any figures. Some said the decrease in average size was slight; others, one-half. The decrease is probably greater than most lobster-men are aware of, and in this connection I will quote Mr. S. M. Johnson, of Boston: "They decreased rapidly until the law was enacted regulating the size of those brought to market, the enforcement of which arrested the apparent decrease.

"I would say here that the effect of a law regulating the size of those saved for food is, after a time, to bring a very large majority of those offered for sale to about the legal limit, and an improvement can only be looked for by increasing the limit from time to time."

As to the annual rate of growth the replies of the lobster-men are without value, as they have no means of correct observation in a matter of this kind; their answers differed very widely. Neither can I find any published data on the subject, though some such may exist which I have overlooked. I am, therefore, unable to give the length of time required by a lobster to attain the adult size. I will, however, again quote Mr. Johnson, and can say that what are, perhaps, the most trustworthy observers agree more or less closely with him, as regards rate of growth between periods of shedding:

"The rate of growth, if estimated by weight, is probably about double at each shedding. If taken by measurement, my own observation has been directed to one size with this result: A lobster measuring just ten and one-half inches after having shed measured eleven and one-half and as high as twelve inches in some cases. The above fact I consider of great importance in seeking for the best way to protect the lobster fishery."

SHEDDING.

Now the question naturally arises, how often does the lobster shed? One correspondent says:

"They shed, I think, during the greater part of the year, but principally from July to October. The process is more influenced by amount of food, (good pastures, so to speak), than by the season or temperature. They must shed in order to grow, and if they get plenty to eat they will grow. In the early stages of their growth, the process of shedding goes on quite rapidly and becomes less frequent year by year as they attain age, and having become fully grown the process stops altogether."

They probably shed, when partially grown, only once a year, or, at any rate, not more than twice a year; but it must be remembered that the young have to undergo many changes in order to attain the length of even a few inches. The very young, however, shed very rapidly, going through many changes in the course of the first season or summer. A lobster eight inches long will, after shedding, measure about ten inches, but from the very young to eight inches my data is deficient.

I have written to Prof. S. I. Smith, of Yale College, on the subject of growth, but he was unable to give me any satisfactory answers. Prof. Smith is probably the best scientific authority on the subject in this country.

Just before shedding, the lobster is said to be full and heavy, but immediately after shedding it becomes thin and watery and unfit for food. Nevertheless soft-shell lobsters are said to be used in the lobster canneries of Maine.

SPAWNING.

The question was put to the correspondents, Do lobsters spawn all through the year? One-third answered, "No;" the remainder, "Yes." Lobsters with spawn can, most likely, be found at all seasons, but during certain parts of the year, probably only in small numbers. The summer seems to be the principal spawning season, and most of the statements I have indicate that the eggs begin to appear about March, and hatch from June to September. Still this statement must be tempered with the above, that some spawning lobsters are to be found all the year through.

We have no data as to the exact length of time any single lobster carries her spawn.

As to the size of the smallest lobsters seen with spawn, the correspondents differed in their answers, from eight inches to twelve inches. There seems to be no definite data as to the size and age of lobsters at maturity. It may vary at different points along the coast (with temperature), but, if so, we have no knowledge of it. I will quote the answer we have had from Mr. S. M. Johnson on this point. We consider him one of the very best authorities we have regarding the lobster:

"Have never seen caught east of Cape Cod more than two or three specimens that were under ten and one-half inches long (with spawn), and these, I think, were fully mature, but dwarfs. I think but a small proportion spawn under eleven inches in length, and I have always been of the opinion that this is the proper limit below which none should be saved for food, in order to fully protect the species."

The spawning lobster is probably more inactive, or torpid, than those without spawn.

REFERENCES.

The following publications will give additional data regarding the natural history of the American and European lobster:

The Norwegian Lobster Fishery and Its History, by Axel Boeck. [Report U. S. Fish Commission, Part III., pp. 223–258.]

On the Artificial Propagation of the Lobster (in Europe). [Fish Commission, Report III., pp. 267–269.]

The Metamorphoses of the Lobster and other Crustacea, by S. I. Smith. [Fish Commission Report, I., pp. 522–537.]

The Lobster (*Homarus Americanus*): Extent of the Fishery—The Spawning Season—Food—Shedding—Legislation. Wm. W. Wheildon. [Proceedings of the American Association for the Advancement of Science, XXIII., 1874, pp. 133–141.]

Forest and Stream, etc.

S. I. Smith. The Early Stages of the American Lobster. [Trans. Conn. Acad. of Sciences, Vol. II., pp. 350–381, 1873.]

Frank Buckland and others. [Reports on the Crab and Lobster Fisheries of England and Wales, Scotland and Ireland. London, 1877.]

Also by the same, other reports to the British Government on the same subjects.

NOV 21 1923

State of Rhode Island and Providence Plantations.

29,150

ELEVENTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, A. D. 1882.

PROVIDENCE:
E. L. FREEMAN & CO., PRINTERS TO THE STATE.
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1882.

REPORT.

To the Honorable General Assembly:

The Commissioners of Inland Fisheries beg leave to present their annual report for the year 1881:

BAY FISHERIES.

At the January, 1881, session of the General Assembly, it was enacted as follows:

CHAPTER 865.

"*An Act in Amendment of Chapter 751, of the Public Laws, entitled 'An Act in Amendment of Chapter 134 of the General Statutes,' of Certain Fisheries.*"

SECTION 1. Section 1 of Chapter 751 of the Public Laws is hereby amended so as to read as follows:

"SECTION 1. There shall be between the first day of May and the first day of August in each year, a weekly close-time, extending from Saturday morning at sunrise to Monday morning at sunrise, during which time no fish of any description shall be taken by weirs, traps or similar contrivances, from any of the waters of the coast line of the State and Narragansett Bay. If there be any weir, trap or other stationary contrivances used for the purpose of catching, or obstructing the passage of fish, in that part thereof where the fish are usually taken, the netting at the mouth of the same shall be floated to the surface of the water, so as to effectually close the mouth thereof during the weekly close-time, so that during said time the fish may have a free, unobstructed passage; and no device shall be placed in any part of said limits which shall tend to hinder such fish from running up the waters of such river. In case the enclosure where the fish are taken is furnished with a board floor, an opening three feet wide shall be made extending from the floor to the top of the weir, trap or other contrivance: *Provided*, however, that nothing herein shall be so construed as to apply to the shad and herring fisheries in the tributaries of Narragansett Bay.

It will be seen that this amendment of Chapter 751, extends the close-time law to all the waters of the State, while before said law applied only to the waters of Narragansett Bay, north of a line drawn from the south end of Sakonnet point to Narragansett Lower Pier. The increase of territory to protect and the added number of heart nets made a larger number of assistants necessary to properly enforce the law, the Commissioners, therefore, engaged the services of Captain Samuel Place of Warren, (whom we have formerly employed), Captain Wheaton Cole of Warren, Captain Brown of Warren, Captain Gardiner of Wickford, E. F. Lewis of Westerly, and P. T. B. Smith of Newport. These assistants were given their grounds to cover as near their respective residences as possible to save expenses, and all performed their duties faithfully and satisfactorily; at least no complaint of any dereliction of duty has been reported to your Commissioners. At Sakonnet Point there were five (5) traps; at the south end of the island of Rhode Island, nine (9), and in the vicinity of Watch Hill, east and west, six (6); making twenty (20) all told. There was no disposition on the part of the fishermen to evade the law; every trap-owner or Captain of a gang was served with a printed notice giving the law as amended, and informing them of the determination of the Commissioners to enforce the same; and if all classes of the community were as law-abiding as the fishermen have proved themselves to be the past year, it would be a blessing.

The catch of scup was small all along the coast, but prices were fair and in some cases high, and the men got an average fair return for their labor. Taken year by year, what with comparative scarcity of some seasons, abundance another but with very low prices, and the damage to the traps by heavy weather, it would seem as if the trapper's business was not very remunerative, and that they may be said to fairly earn their money.

In the bay, scup of fair size have been very abundant the past summer, more so, it is asserted, than for the past fifteen years, and the advocates of the close-time law have again, as they had last year, reason for congratulation, and good arguments in its favor for the future. The Commissioners of Inland Fisheries do not consider it their duty to advocate one side or the other. They endeavor to give the facts as they find them, to represent the good or ill conduct of the parties most interested as it comes under their notice, and to enforce the law in all cases without fear or favor. In our last report we mentioned the arrest and prosecution of ——— King. This case, owing to the law's delays, has not yet come to trial. The arrest of the individual, however, has had a good effect on those parties who were disposed to violate the law. Judging from the close observance of it, the past season, the lesson was a good one to all interested.

It will be seen by our financial statement appended, that our expenses in properly enforcing the law this year, were about one thousand dollars. It cannot well be done for less, as the men employed must be faithful and energetic, and attend to their duties in all weathers. Such men are not easily found.

HEART NETS.

Forty-nine (49) heart nets were maintained in Narragansett Bay the past summer, an increase of eight (8) over the year previous, and eighteen (18) in two years. This increase is due to the number placed this year in Sakonnet river below Stone Bridge. No less than nineteen (19) being placed there, an increase of ten (10) over the previous year. We desire to call the attention of your honorable body to the fact that six (6) of these destructive machines were maintained by parties living outside of the State of Rhode Island, who lived on board their vessels, loaded the same and sailed away for a market far from our own doors. Other States have laws forbidding this sort of business, and it is high time we enact something of the kind to protect ourselves. As the years go on, and our State increases in population, and our people realize as they begin to do the importance and value of our fisheries, such regulations must come, and we believe the sooner the better. Laws properly enforced require more or less expenditure of money, and money so spent is, we believe, well spent.

In our report of last year, we made sundry suggestions looking to the amendment of our fishery laws. No notice was taken of the same, and we can only say that we have not changed our views in the matter: it only remains for the intelligent and disinterested portion of the community to judge for themselves if we are right or wrong. It is not particularly encouraging for intelligent persons to make a study of a subject, report the same to the best of their ability, and have the same entirely ignored by those under whose orders they act, and to whom they look for support. Why the fishery interest of the State, from year to year, should be left in the hands of a clique, who are either notoriously prejudiced or lamentably ignorant of the subject, is a question that the people of this State may well look into, and so long as this state of affairs continues we may look for no change for the better. Slowly, but surely, however, the general public are being enlightened on the question, and it is reflected in the action of the legislature in the past three years. First, a close-time law was passed from April 1st to August 1st, on all traps and heart nets in Narragansett Bay, from Narragansett Lower Pier to Sakonnet Point; next, a close-time from the same dates including all the waters of the State; also, a proper law protecting lobsters of less than ten (10) inches in length. Other states make it ten and one-half (10½). All this is encouraging, and in the future will no doubt be improved upon; and when the people of this State, and their representatives in the General Assembly are aroused to the fact that in the last twenty years they have allowed the Bay fisheries to be depleted for the benefit of a handful of individuals, to the detriment of the whole community, they will abolish all fixed nets, save fykes with a limit of leaders and capacity, gill nets unless with a certain size of mesh (not less than four inches), prohibit traps save in a few localities and these with a heavy license, allow sweep seines with three-inch mesh, and purse seining under restrictions of lines as set forth in our last report, and abolish all heart nets, so called, or any approach to any such contrivance. Then the people of the State of Rhode Island will have accomplished a good work, and the fish that a bountiful nature sends to our shores will be as abundant as ever, to be taken by all who have the industry to seek them in a legitimate way, our home markets supplied better by such means than they are now, (for most of our fresh fish come from Boston and New York).

Nature supplies fish, and artificial means deplete them at all times, and at the worst times. The scup that comes to our shores laden with spawn and looking for a place to reproduce, are taken by the thousands of barrels from April 20th to June 30th. The markets of New York and Philadelphia and wherever a market may be found are flooded with cheap fish. No one cares, seller or buyer, what the result is, so long as they can sell, so long as they can buy. This lasts for a few weeks, and then good-by to scup. Every spawning fish so caught represents tens of thousands of young. The men who capture them by the thousands of barrels are few and far between. If there are no facilities for a quick sale, they are carted on to the nearest available spot for manure. So with tautog or black fish. In the spring, from say the first to the middle of May, these fish are taken loaded with spawn, by traps, by heart nets and by land lines. It is wonderful how prolific they are, else they would be rarer than rich men in heaven, but we know their abundance despite these draw-backs, and can form no estimate of their numbers if they were properly protected.

Those of our community who are ignorant of, or careless of, the riches that nature, so bountiful on land and sea, gives us each year in the waters of our beautiful bay, may well consider if it is wise to waste it as it has been and is wasted. They should enact such laws as shall check the greed of the few, and inure to the benefit of the many. Proper protection for the food fishes should be as important a question, and legislated upon as carefully as any other subject that comes before the General Assembly, and until that is done we cannot hope for any improvement in the present condition of affairs.

We now give as briefly as possible a list of the traps.

Sakonnet Point—Five (5) traps were set here the past season, begining on the 2d of May. The first week, no fish of any account the second week, about one hundred barrels, mostly tautog and round mackerel, with large quantities of sea-robbins (useful for manure); the third week ending the 23d of May, there were taken about fifty barrels of scup, and fifty barrels of other marketable fish (tautog, sea bass, mackerel and about five barrels of small striped bass); the fourth week, slim fishing, mostly small scup; the sixth week about the same, and all the traps were taken up, save one.

The trap fishermen report a very bad season, and in some individual cases a complete failure. What fish were taken brought good prices, however.

South end of island of Rhode Island, Newport and vicinity—Nine traps were maintained here during the spring and up to the middle and last of June, with about the same results—poor fishing and small profits, with one or two exceptions.

Near Watch Hill were six traps; fishing poor, and great damage done by rough weather; so far as could be learned, very little if any profit.

Twenty traps in all set in Rhode Island waters this season, 1881.

The parties who reside outside of the State, and maintained traps in our waters the past season were:

Capt. George Eadell, sloop Saucy Maid, of Greenport, Long Island, three traps.

Capt. A. J. Rucket, sloop Sapho, of Greenport, Long Island, three traps.

Capt. W. Leet, sloop Flora, of Greenport, Long Island, two traps.

All these were in Sakonnet River.

INLAND FISHERIES.

There were sent to this State from the United States Government hatchery at Havre de Grace, five hundred thousand young shad. These arrived in fine order, and were placed in the upper waters of Warren River. The locality where they were put is to be sure in Massachusetts; but the mouth, and three miles of the river are in this State, and the shad fishery in that portion of it has been of considerable value in years past; in fact, it is the only river we have that is unobstructed by dams, and suitable for shad.

Carp.—Last year we received two hundred young carp; this year we have one thousand, and at this writing we are distributing them to parties who have suitable ponds for them: muddy, weedy, still waters, with no other fish, are where they should be placed, and such ponds (natural) are by no means common. We have no doubt however, but we shall in a few years reckon on the German carp as one of our native fishes.

No black bass have been distributed this year, as we have had no application for them.

ALFRED A. REED,
JOHN H. BARDEN,
NEWTON DEXTER. } *Commissioners of Inland Fisheries.*

State of Rhode Island in account with Commissioners on Inland Fisheries.

1881.				
Feb.	25.	To amount paid A. M. Paul for copying manuscript Report	$4 25	
March	1.	To amount paid A. M. Paul for copying manuscript Report	80	
		To amount paid postage on Reports sent Commissioners	1 12	
June	30.	To amount paid Newton Dexter, Commissioner, for travelling expenses and teams, placing 500,000 shad in Warren River	10 00	
Sept.	2.	To amount paid Providence Press Co. for 1000 posters to Fishermen	2 00	
Nov.	19.	To amount paid Robert Holmes, expenses to Washington and return, and transportation of carp	99 55	
Dec.	10.	To amount paid Knowles, Anthony & Danielson, advertising carp	2 25	
	12.	To amount paid Albert M. Paul, copying manuscript Report	1 25	
	13.	To amount paid Geo. H. Downer for 10 years' service as Clerk to Commissioners, from 1871 to 1881, inclusive	80 00	
1882.				
Jan.	5.	To amount paid John H. Barden, Commissioner, to expenses to Wood's Hole to meet Prof. Baird	6 50	
				$207 72
	5.	To balance carried forward		422 29
				$630 01

Cr.

1881.				
Feb.	28.	By balance on hand this day	$130 01	
		" amount appropriated this year	500 00	
				$630 01
1882.				
Jan.	5.	By balance brought forward	$422 29	

PROVIDENCE, January 5th, 1882

State of Rhode Island in account with Commissioners on Inland Fisheries, for account Bay Fisheries.

Dr.

1881.				
June	20.	To amount paid G. B. & J. H. Utter for printing Trap Laws	$6 00	
		To amount paid John H. Barden, Commissioner, travelling expenses	8 42	
Sept.	1.	To amount paid Deputies for expense and services watching traps,		
		John S. Brown, Warren	210 00	
		Wheaton Cole, "	197 96	
		Samuel Place, "	205 25	
		J. V. Gardiner, Wickford	104 00	
		Edward F. Lewis, Westerly	139 10	
		Pardon T. Smith, Newport	70 00	
Dec.	12.	To amount paid Albert M. Paul, copying manuscript Report	1 25	
	13.	To amount paid Geo. H. Downer for three years' services as Clerk to Commissioners, 1879, 1880, 1881.	24 00	
				$965 98

Cr.

1881.				
Sept.	1.	By cash received from State	$940 73	
Dec	13.	" " " "	25 25	
				$965 98

PROVIDENCE, January 5th, 1882.

NOV 21 1923

State of Rhode Island and Providence Plantations.

29.150

TWELFTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1883.

PROVIDENCE:
E. L. FREEMAN & CO., STATE PRINTERS.
1883.

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TWELFTH ANNUAL REPORT

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COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

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AT ITS

JANUARY SESSION, 1883.

PROVIDENCE:
E. L. FREEMAN & CO., STATE PRINTERS.
1883.

REPORT.

To the honorable General Assembly of the State of Rhode Island, January Session, 1883:

The commissioners of inland fisheries respectfully beg leave to present the following brief report for the year 1882.

BAY FISHERIES.

No changes have been made in the statutes relating to fisheries in this State, since our last report.

By the last week in April the traps for the catching of scup and other fish were in place, and ready for business, to the number of twenty-five, an increase of five over the past year.

From Seaconnet Point to Watch Hill scup were taken, in small quantities, by the end of the first week of May.

The second week of May opened very favorably for the fishermen, and large catches were disposed of at good prices. As usual the great bulk of the catch was shipped to New York and Philadelphia.

On the third week came disaster, and at the very height of the fishing. A northeast gale, with heavy seas, tore up the traps, destroyed some, damaged all, and in exposed places ruined all chances for profit for the season.

At Boathouse Point (south end of the island of Rhode Island) the loss was estimated at 600 barrels of fish, and at Seaconnet 1,000 barrels. At Watch Hill loss occurred.

After the bad weather the traps were at work again, but the great run of fish had gone by, and for the rest of the season, lasting into June, poor fishing was reported.

About the first week in July the second run of scup, what are called summer scup, came into the bay, of fair size, and rather plentifully. The heart nets took them in large quantities, and from High Hill to Stone Bridge (Seaconnet River) several thousand barrels were shipped to New York and Philadelphia. Shipping scup so late in the season has never occurred before.

There were ten traps at Watch Hill and vicinity, ten at the south end of the island of Rhode Island, and five at Seaconnet Point.

Some of these traps made money. At Price's Neck they sold $3,000 worth of fish, and Mr. Lamphear, at Watch Hill, sold $2,500 worth before his trap was destroyed by bad weather.

As we have before reported, there is a great deal of uncertainty in the profits of trap fishing, rough weather, as in the past year, ruins the chances, and if the whole business were forbidden, save at Seaconnet Point, and a license paid there by the trappers sufficient to pay the expenses of supervision, the State at large would profit by it, and the men engaged in it would seek a more profitable occupation, and in the end would be benefitted.

We have, in previous reports made to your honorable body, given the result of our experience, and suggested changes and amendments. None of these have been acted on, and we make no more. We have only to add that our opinions are unchanged.

HEART NETS

set in the bay were as follows: 72 in all, an increase of 23 over the past year, a number of them maintained by parties not resident in the State. We have before called attention to this fact, and the destructiveness of these fixed engines. It is not worth while to waste money in printing our views any farther. We have only to say, as we have said before, they should be forbidden.

Most of the catch is sent away from this State, and the people are not benefitted by it. We beg to call your attention to this matter.

The catch of tautog, a black fish, in the bay, the past season was very good, presumably owing to the destruction of the traps at about the time of their spring run.

Striped bass very scarce, and menhaden exterminated almost, consequently no bluefish.

INLAND FISHERIES.

We have to report that our plant of carp have in several instances shown a remarkable increase in growth. One and one-half pounds have been reported as occurring in one year, in two instances. This fish in our opinion will take a place among our food fishes, and prove its value. About twelve hundred so far have been distributed.

No shad were distributed the past season, for the reason that they could not be had from Washington, the hatching not being so successful as usual, and the supply was limited.

We had no applications for black bass, and so supplied none.

We append a list of the ponds in this State stocked by the present commissioners, in the past twelve years, with land locked salmon and black bass.

LAND LOCKED SALMON. 1876.

Wallum Pond	in	Burrillville.
Moswansicutt Pond	"	Scituate.
Steere's "	"	"
Searles "	"	Foster.
Lilly "	"	"
Gorton's "	"	Warwick.
Warwick "	"	"
Beach "	"	Richmond.

About 20,000 were put in these ponds, but we fear our waters are not suited to them.

BLACK BASS.

The following ponds have been stocked with black bass, by the present commissioners. We give the list for convenience of reference :

1870.

Wauchog Pond	in	Charlestown.
Moswansicutt Pond	“	Scituate.
Sneach “	“	Cumberland.
Herring “	“	Burrillville.

1871.

Steere's Pond	in	Scituate.
Hope “	“	“
Ponegansett Pond	“	“
Searles “	“	Foster.
Speares “	“	“
Scott's “	“	Lincoln.
New Reservoir “	“	Lonsdale.
Warwick “	“	Warwick.
Gordon “	“	“

1872.

Stafford Pond	in	Tiverton.
Easton's “	“	Newport.

1873.

Yawgoo Pond	in	So. Kingstown.
Worden's “	“	“ “
Belleville “	“	No. “
Johnson's “	“	Coventry.
Wickaloxet Pond	“	West Greenwich.
Deep “	“	Exeter.
Yawgook “	“	Hopkinton.
Two ponds	on	Block Island.

1880.

Georgiaville Pond ....in Smithfield.

In most of these ponds the fish have done remarkably well. The following is our financial statement for the past year.

NEWTON DEXTER, ALFRED A. REED, JOHN H. BARDEN, } *Commissioners on Inland Fisheries.*

State of Rhode Island in account with the Commissioners on Inland Fisheries.

1882.			
March 11.	To amount paid telegram to Washington...........	$0 25	
May 24.	" " " postage on commissioners' reports..	88	
			$1 13
	" balance carried forward........................		421 16
			$422 29
1882.	Cr.		
January 5.	By balance on hand this day..........		$422 29
1883.			
January	By balance on hand this day brought forward......	$421 16	

Providence, January 31st, 1883.

State of Rhode Island in account with Commissioners on Inland Fisheries, for account Bay Fisheries:

1882.		
June.	To amount paid deputies for expenses and services watching traps :	
	J. V. Gardiner, Wickford..................................	$32 00
	Edwin F. Lewis, Westerly	88 00
	Pardon T. Smith, Newport..........................	68 00
	Wheaton Cole, Warren.................................	60 00
	Samuel Place, "	100 00
	Alfred A. Reed, Jr., Commissioner, Coweset Bay.......	4 00

July.	Wheaton Cole, Warren	60 00	
	J. V. Gardiner, Wickford	32 00	
Aug.	" " "	40 00	
	Wheaton Cole, Warren	75 00	
	Pardon T. Smith, Newport	62 00	
Sept.	Samuel Place, Warren	144 15	
	Edwin T. Lewis, Westerly	88 00	
	" " " "	105 00	
	John S. Brown, Seaconnet Point, 3 mos services	195 00	
Dec.	To amount paid Miner & Roelker bill, May, 1882, for professional services, examining fish laws of New York, Connecticut and Massachusetts	35 00	
	To amount paid C. A. Green, advertising fishery laws in Bristol Phœnix, April and May	8 25	
	To amount paid Geo. H. Downer, for services as clerk to commissioners	16 00	
			$1,212 40

1882.	Cr.		
June 27.	By cash received from State of Rhode Island	$252 00	
Sept. 6.	" " " " " "	369 00	
Oct. 23.	" " " " " "	532 15	
1883.			
Jan. 31.	" " " " " "	59 25	
			$1,212 40

Providence, January 31st, 1883.

29,150

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

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COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

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AT ITS

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PROVIDENCE:
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1890.

APR 28 1897

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

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COMMISSIONERS OF INLAND FISHERIES,

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AT ITS

JANUARY SESSION, 1890.

PROVIDENCE:
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1890.

REPORT.

To the Honorable General Assembly of the State of Rhode Island, etc., at its January Session, 1890:

The Commissioners of Inland Fisheries herewith present their Annual Report for the year 1889:

SHAD.

We received through Col. M. McDonald, U. S. Fish Commissioner, about three million shad fry, sent in their special tank car. These were placed in Palmer river, at Shad Factory, it being, in the estimation of the Commissioners, the waters best suited to them, as there are no insurmountable dams or other serious obstructions to their return. The only expense to the State for this large installment of shad fry was the transportation from car to river.

TROUT.

The Commissioners have distributed personally and through others interested in the increase of fishes in our inland waters, nearly ten thousand (10,000) trout fry and yearling trout in the various public streams and ponds of our State. The past open season for trout fishing (from March 1 to August 15) has demonstrated to the entire satisfaction of your Commissioners that their efforts in this direction, as well as those of their predecessors, have not been useless, neither have the expenditures of the State's moneys been lost to it. That such is the fact need not be told by us, as ample evidence can be obtained from the merest tyro. It has been brought to our attention continually during the past season that such large catches of trout have been unknown for years, and the fish averaging good size. Of course, nature has helped us very materially in this regard; the continued high water in the brooks and ponds during the summer and fall, and mild winters for the last few years, has been a very important factor.

The Commissioners have come to the conclusion to hereafter put in yearling trout instead of fry; the expense will not be much greater, and actual results can be seen and benefits received sooner.

Through the courtesy of Col. M. McDonald, the State is to receive ten thousand (10,000) land locked salmon eggs, as well as ten thousand (10,000) Penobscot salmon eggs. These will be distributed in the various waters of the State suited to them, with the mere expense to the State of hatching and planting.

The Commissioners have been informed of young salmon "Parr" being taken by parties fishing for trout, which shows that they thrive in our waters. These were undoubtedly a part of those put in by us last year.

The Governor and Council of the State of New Hampshire have kindly donated twenty thousand (20,000) lake trout eggs. These were obtained through the generous efforts of Col. E. B. Hodge, Fish Commissioner, and as he says in his letter to us were "obtained from trout weighing from ten to twenty pounds," we hope to obtain good results from them.

The Sea Fisheries of this State must ever be, as in the past, of great interest. We regret that we have not better means of procuring correct and complete statistical data. We give such as we have been enabled to procure at this time, trusting that in our next report we shall be able to give much more in this line, believing it to be of the greatest value in arriving at an intelligent understanding of the subject.

Most of the changes in our fisheries are phenomenal, the fluctuations in numbers are beyond calculation from any known data, and so varied from unknown causes, that it is useless to estimate the future from observation of the past. Especially is this true of the anadromous fishes of the ocean that visit our waters, and strangely enough no past investigation has revealed their location or history while absent from us. While considering this part of our subject, we find the following paragraph in one of our papers, which, if it fails to establish facts that will give light upon this mysterious question, is not without interest:

> "WHERE THE MACKEREL ARE.—The United States Fish Commissioners say that there are plenty of fish somewhere all the year round, and that what are caught by the fishermen do not deplete their number to any great extent. These commissioners prove their statements as a general thing, and have done so in regard to the mackerel. Last season this commission hired a man to go to the Cape of Good Hope to look for mackerel on that coast, the commission to pay him and his expenses for the trip. He was from Harwich, Mass., a well known mackerel killer. When he arrived at the coast of Africa, the shores were teeming with mackerel eighteen inches long and fat. They were easy to catch. He soon captured a cargo of mackerel and the vessel is nearly due. He could not obtain barrels there the kind usually used for fish, so he put the fish down in wine barrels. The man informed the fish commissioners that he would pay his own expenses, without recourse to them. He will make one thousand dollars, at least, out of this single cargo. It appears that the mackerel have gone across the ocean, perhaps for a few years' pastime. Probably a fleet of mackerel schooners will go there from the United States as soon as full returns are given from this vessel.—*Fall River News.*"

If it should be proved that what we have been accustomed to consider as our own fish, by their long residence in or near our waters, are cosmopolitans, and claim the world as their own and vary their location without limit of space as the season changes, then have we a phase of this question not before presented to us. It has long been known that mackerel have been found in widely separated parts of the world, while of some of the others of the fish that periodically visit us, such as the scup for instance, are believed to be peculiar to this locality, and to a comparative restricted portion of the coast. The most important of the wandering fishes that yearly visit us are the scup, mackerel, horse-mackerel, bass, squeteague, sea-bass, herring and menhaden.

On these wandering fishes of the ocean we chiefly depend for our summer fishing. They appear on our coast the last of April, or more often in early May, in large schools, and remain with us more or less all summer in diminished numbers, or so scattered as to appear greatly diminished in numbers. The habits of these fish are quite different. Of edible fish the scup are decidedly the most numerous, and, excepting the herring, the first to come. When they arrive on the coast they are in large schools and swim near the surface, but later on they scatter throughout the waters and become a bottom fish. This was true of them in former years, when they remained throughout the season in large numbers and rarely failed to make good fishing with hook and line. The earliest settlers found them abundant, but from some cause they left our waters and reappeared in 1793, first in small numbers, but increasing from year to year until they became the most numerous of all our edible fish. They seem to have grown in disfavor as they increased in numbers, until their low value caused them to be used as a fertilizer, but a widened market has served to restore these once despised fish to their deserved place among edible fish. From their reappearance in 1793 they have been more or less plenty in our waters every year. The very young fry seen here indicate that they spawned in our waters.

A few years ago the phenomenal appearance of the young of these fish, about two inches long, from some unknown source baffled all calculation in regard to them. The past season has been a peculiar one; large schools of them came on our coast, in as large if not larger numbers than ever before, but very few came into the bay, and fishing for them has been very poor during the season. It is also observed that last year (1889) the fish came in shore as in former years, while in the two or three preceding years they were taken much more successfully in the off shore traps.

We furnish a statement of the shipment of fish by the New York steamers for the last four years, and as the great bulk of the fish so shipped were scup, some estimate of the comparative catch can be made. We also have the statement kindly furnished us by the Messrs. J. Church & Co., which shows their catch to be in these four years as follows:

1886	about 4,000 Barrels	Average price per Barrel	$7 00
1887*	estimate 10,000 "	" " " "	3 00
1888	7,000 "	" " " "	4 00
1889	between 10,000 and 12,000 "	" " " "	2 50

These figures are made from records and estimates of the shipment when made in bulk.

Amount of Edible Fish and Lobsters shipped from Newport by way of Old Colony Steamboat and Railroad lines.

Year.	
1886	17,484 Barrels Fish, including Lobsters.

1887.	FISH.	LOBSTERS.
January	6 Barrels	25 Barrels.
February	9 "	33 "
March	26 "	37 "
April	85 "	94 "
May	10,293 "	51 "
June	4,148 "	20 "
July	900 "	184 "
August	349 "	213 "
September	431 "	100 "
October	293 "	34 "
November	87 "	15 "
December	30 "	88 "
Total	16,657 Barrels	834 Barrels.

1888.	FISH.	LOBSTERS.
January	68 Barrels	31 Barrels.
February	85 "	7 "
March	30 "	14 "
April	157 "	155 "
May	5,605 "	177 "
June	6,813 "	159 "
July	1,407 "	179 "
August	465 "	197 "

---

* The record was lost for year 1887.

September	316 Barrels	112 Barrels
October	55 "	55 "
November	47 "	11 "
December	64 "	64 "
Total	15,038 Barrels	1,161 Barrels.

1889.	FISH.	LOBSTERS.
January	14 Barrels	91 Barrels.
February	24 "	69 "
March	98 "	98 "
April	89 "	221 "
May	11,872 "	205 "
June	5,157 "	197 "
July	754 "	417 "
August	367 "	406 "
September	246 "	140 "
October	220 "	59 "
November	214 "	10 "
December	251 "	134 "
Total	19,306 Barrels	2,047 Barrels.

TOTAL OF FISH AND LOBSTERS.

1886	17,434 Barrels.
1887	17,491 "
1888	16,194 "
1889	21,353 "

HERRING

are reported to be plenty, but of little value owing to the early catch of other fish.

SEA-BASS

commenced to run upon our coast about May 20th, but not in so large numbers as in former years.

STRIPED-BASS.

Of this highly prized game fish more are reported than for some years past, but they were far from plenty.

BUTTER-FISH.

Less than usual.

MACKEREL.

While these fish are reported to have been quite plenty in our waters, the catch was much below preceding years.

"EARLY MACKEREL.—Captain Hopkins of schooner Mabel Howard, which arrived at Boston Friday from Kingston, Ja., reports that on February 28, when 45 miles off Nantucket, passed a large school of mackerel. The presence of mackerel so far north at this season of the year is believed to be without precedent, as they seldom appear in schools off the United States coast before the latter part of March or first of April, and are almost invariably seen first in or near the latitude of Cape Hatteras.

The mackerel are as much ahead of their usual time as the icebergs were, which became numerous in the track of European steamers in January. Mackerel are governed in their movements by the temperature of the water, and their presence off Nantucket indicates that the water in that vicinity is now of about the same temperature as the waters off Cape Hatteras usually are in the latter part of March. This is, indeed, a remarkable season.—*New Bedford Mercury, March 4, 1890.*"

HORSE-MACKEREL (BLUE-FISH)

were more plenty than preceding year and for a short time quite plenty, but remained for a short time. The Baltimore Sun's Norfolk, Va., correspondent writes March 3, 1890:

"Vessels coming in from the Roanoke island section say that the coast is literally lined with blue-fish. One seine fishery on Thursday caught 600 and odd shad and 30,000 herring at one haul. The pound-net fishermen are also doing good work. The spring fishing season is now fully on, and the fish trains from Elizabeth City come in heavily loaded. Later on the steam fisheries on Albemarle sound will be making the 100,000 herring hauls. The truckers of Norfolk County, Va., now have green peas in blossom, several weeks earlier than usual, and are cutting and shipping asparagus."

SQUETEAGUE

were less than usual.

TAUTOG

are reported fairly plenty and good fishing for them in the lower waters of the bay. These fish are more local in their habits and never go far from us even in the colder months. We know of a catch of thirteen, weighing 30 pounds, on the first day of January last. The same person reports that he caught 150 pounds of large chogsets the same day. This is certainly very unusual at this season of the year, but the season being unusually mild may account for it.

MENHADEN.

The menhaden are by far the most numerous of all our fishes. They are little used as an edible fish, but are of considerable commercial importance, as will be seen by the report made by the oil factories.

THE MENHADEN FISHERY FOR THE LAST FOUR YEARS.

This fishing for the year 1886 commenced the first of June and continued until the 17th of November, and extended from Seaconnet to Cape Henry; were most plenty on the south of Long Island; very few in Rhode Island waters. The catch this season was as follows:

Steamer	Joseph Church	with 2	gangs	33,406	Barrels.
"	A. M. Hathaway	" 2	"	33,406	"
"	George Curtis	" 1	"	22,231	"
"	Cora P. White	" 1	"	15,876	"
"	Seven Brothers	" 1	"	9,456	"
"	Fanny Sprague	" 1	"	8,375	"
"	George W. Humphrey	" 2	"	45,389	"
	Received at factory from other boats.			12,006	"
"	Seaconnet	" 2	"	29,199	"
"	Fearless	" 1	"	8,500	"
"	John A. Morgan	" 1	"	9,922	"
Schooner	Penekese	" 1	"	2,707	"
	Total catch for the year 1886			232,471	Barrels.

YEAR 1887.

The fishing season this year was from July 1st to the last of October, from Montauk to Cape Henlopen. The catch was very small, Capt. Church reports no large bodies of them on the coast and but few days of good fishing. No fish east of Block Island, none worth mentioning in Rhode Island waters. . The catch this season :

Steamer	Joseph Church	with	2	gangs	23,123	Barrels.
"	A. M. Hathaway	"	2	"	28,020	"
"	George Curtis	"	1	"	19,398	"
"	Cora P. White	"	1	"	12,463	"
"	Seven Brothers	"	1	"	3,801	"
"	Fanny Sprague	"	1	"	8,468	"
"	George W. Humphrey	"	2	"	35,335	"
	Received from other boats				639	"
"	Seaconnet	"	2	"	23,300	"
"	Fearless	"	1	"	9,700	"
"	John A. Morgan	"	1	"	11,297	"
Schooner	Penekese	"	1	"	123	"
	Total				175,667	Barrels.

YEAR 1888.

Fishing Season from June 12th to November 12th.

The very poor fishing the season before led the fishermen to expect little this season, and they proposed to begin late if at all; but the presence of the fish in large numbers induced them to begin early, and they found them abundant throughout the season from Block Island to the coast of Maine and quite plenty as far south as Delaware. The catch this season :

Steamer	Joseph Church	with	1	gang	61,906	Barrels.
"	A. M. Hathaway	"	1	"	42,282	"
"	George Curtis	"	1	"	23,753	"
"	Cora P. White	"	1	"	38,906	"
"	Seven Brothers	"	1	"	19,963	"
"	Fanny Sprague	"	1	"	30,326	"

Steamer George W. Humphrey	with 1 gang	53,339	Barrels.
Received from other boats		13,392	"
" Seaconnet	" 1 "	47,000	"
" Fearless	" 1 "	36,763	"
Schooner Penekese	" 1 "	9,977	"
Total		377,607	Barrels.

YEAR 1889.

Fishing season from June 10th to November 20th. They were very abundant on the whole coast of New England, from Montauk to Eastport, Maine. Our bay and rivers were well stocked with them from June until September. It is interesting to note the fact that six weeks good fishing were found on Nantucket Shoals, where a school of these fish had never before been seen by the fishermen, and notwithstanding the great catch it would have been largely increased but for the blowy weather, and immense numbers left our coast. The catch this season:

Steamer Joseph Church	with 1 gang	63,728	Barrels.
" A. M. Hathaway	" 1 "	66,418	"
" George Curtis	" 1 "	55,228	"
" Cora P. White	" 1 "	48,667	"
" Seven Brothers	" 1 "	22,115	"
" Fanny Sprague	" 1 "	34,580	"
" George W. Humphrey	" 1 "	93,700	"
Received from other sources		10,778	"
" Seaconnet	" 1 "	50,297	"
" Fearless	" 1 "	52,403	"
Schooner Penekese	" 1 "	10,568	"
Total		508,482	Barrels.

RECAPITULATION.

Total catch of Menhaden in 1886	232,471	Barrels.
" " " " " 1887	175,667	"
" " " " " 1888	377,607	"
" " " " " 1889	508,482	"

The menhaden fishery has been remarkable the past season, the catch far surpassing anything before known. Their presence in large numbers has been general along the coast, and some of the steamers took four times what the best catches were a few years ago upon the coast of Maine, where they were thought to be very plenty, in spite of the continuous high winds that prevailed last season. It will be noted in the preceding tables that in the last two years there was a reduction in the number of gangs equal to one-third less men and also one less steamer.

It is the purpose of the Commissioners to present, as far as practicable, a correct statement of all the facts relating to our fisheries that may be of interest to our people, but not in the interest of one side or the other of any controversy or theory. We would be glad to correspond with any one having information that is of public interest upon this subject. We shall strive to avoid any statement not generally admitted unless sustained by the facts. We are aware of the difficulty of obtaining exact data, and we shall avoid dogmatic conclusions upon questionable points from imperfect or contradictory testimony, that may be upset by facts before they get into print. It is hoped to make their report a reliable compendium of the fisheries of this State. Should any error occur we would be glad to have it pointed out and corrected.

Experience has taught us that statements of fishermen vary much according to locality or individual experience in the same locality; what may be strictly true of one locality may seem very wrong if applied to another locality, even if not far removed.

We invite the coöperation of fishermen and others to aid us in the work. Especially would we ask them for statistics of their catches and an account of any unusual occurrence or phenomena they may observe.

The Hon. John H. Barden, who, since the formation of the Commission of Inland Fisheries, has practically been at the head of it, and to whose previous efforts we are largely indebted for the Commission, declining to be reappointed, has been succeeded by Mr. J. M. K.

Southwick, of Newport. Mr. Southwick brings to the Commission a large experience with the salt water fishing which cannot but be favorable to the work entrusted to us.

State of Rhode Island in account with Commissioners of Inland Fisheries.

DR.

1889.			
May	2.	Paid for 50,000 trout eggs	$90 00
	3.	Paid for stationery, etc	13 00
	16.	Expense depositing 2,500,000 shad fry in Palmer river	20 75
Dec.	26.	Expense of Commissioners distributing trout fry, traveling, etc.	25 14
			$148 89

CR.

Cash received from State Treasurer	$134 77
Balance due Commission	$14 12

Respectfully submitted,

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
Commissioners of Inland Fisheries.

NOV 21 1923

State of Rhode Island and Providence Plantations.

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ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1891.

PROVIDENCE, R. I.
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1891.

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1891.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1891:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1890.

TROUT.

40,000 eyed brook trout eggs were purchased by us. These were successfully hatched by Mr. Charles A. Hoxie of Carolina.

The same plan as pursued by us last season, of keeping the trout fry in artificial ponds during the warm weather, placing them in the streams as late as December, was followed this season with very gratifying results. The fry in the early part of December are from four to eight inches in length, and able to look for themselves. We were able to supply all applicants, and not a fish was lost in transportation.

It is remarked by all who are conversant with the streams of our State, that the increase of brook trout has been remarkable.

The past two or three seasons have been favorable for re-stocking the streams, and the results have exceeded our expectations.

LAND-LOCKED SALMON.

Colonel McDonald, United States Fish Commissioner, gave us ten thousand land-locked salmon eggs. From these in December we had upwards of four thousand fry averaging over five inches in length.

These were placed in our deepest ponds without any loss. There is no doubt in our minds of our being able to, within four years, having a satisfactory showing in many of our ponds of this, the king of all inland fishes. Repeated efforts of stocking with small fry have proved futile.

BLACK BASS.

This fine, as well as game fish, is increasing in our waters and gaining popularity as an edible fish. Some large catches have been reported to us.

GOLD FISH.

Colonel McDonald also presented us with about four thousand gold fish, differing in variety, taken from the Government ponds.

These were given to several cemeteries, Butler Hospital and Roger Williams Park.

BAY AND SHORE FISHERIES.

The fishing in the waters of the upper part of the bay has run very good the past season. Tautog and scup quite plenty; small sand scup having been taken very plentifully at Pawtuxet, and all the shore resorts. Small mackerel (tinkers) have also been caught at Bower's Cove and at India Point wharves,—something heretofore quite unknown to the commissioners, if not to older fishermen.

THE SEINE FISHERIES.

This branch of industry has not been so remunerative as in some other seasons, owing to unfavorable weather and the very low prices obtained. The traps as a rule have not done well. The sportsmen have had all they wanted of small scup, and little mackerel, while the larger game, as bass, blue-fish and tautog, have not been wanting, and the hook and liner has been well rewarded by large catches.

The most notable feature of the fish business this year has been the extremely low prices, and abundant supply throughout the entire season.

SCUP.

These fish were not plenty in the spring, and the weather was not favorable to a large catch. The catch in the traps commenced on 27th of April and continued to the 23rd of May. The total catch at Coggeshall's Point was 7,500 barrels; all others about 1,600 barrels; total, 9,100 barrels.

The large scup were very scattering in the bay, but from the first of May small scup appeared in immense numbers, but very small, it taking twenty to weigh one pound. They came into all parts of the bay and were caught everywhere during the summer.

In the early fall they were still plenty and six of them would weigh one pound, showing the season's growth.

On the 4th of May codfish were very abundant. From one of them twenty-seven scup were taken.

The run of fish this season was about two weeks earlier than last.

Captain N. B. Church, to whom we are indebted for much valuable information and who has kindly allowed us the use of his journal, records that "The number of codfish caught in traps was unprecedented; sometimes a ton were taken at one haul. That he saw more squeteague, blue-fish and sea-bass than ever before in all his experience. The blue-fish were observed the whole length of the coast, from Barnegatt, N. J., to Sequin Island, Maine.

"The squeteague were plenty in Seaconnet River for about six weeks, beginning to run, I think, about the middle of June. They were so plenty that the people made but little exertion of catching them, as they would not bring enough in the market to more than pay the shipping bills. The same is true with the blue-fish.

"That the blue-fish ruined the menhaden fishing in this section."

The following table shows the amount of fish and lobsters sent by way of Old Colony Steamboat and Railroad Lines from Newport, for each month in the year 1890:

	Fish.		Lobsters.	
January	56	barrels	148	boxes.
February	36	"	118	"
March	48	"	147	"
April	861	"	235	"
May	5851	"	224	"
June	506	"	419	"
July	339	"	576	"
August	84	"	507	"
September	342	"	136	"
October	487	"	27	"
November	304	"	50	"
December	19	"	63	"
	8933	"	2650	"
To this must be added the amount shipped in fish steamers	3345	"		
Making total of fish	12,278	"		

These figures do not include all the fish shipped. Quite a number of barrels were sent to Providence; besides, we have no account of what went over the Stonington Road.

From one-half to three-fifths of these fish are scup; the balance comprise all the varieties of edible fish found in our waters.

MACKEREL

Have not favored us with their presence in large numbers.

September 23d they put in their appearance and several hundred barrels were taken; but they soon left us under sealed orders, as suddenly as they came, while their smaller relatives, the "little mackerel," remained with us in good numbers for a long time.

HORSE MACKEREL.

The late Professor S. F. Baird, in his report for 1871 and 1872, under the head of "Natural History of Important Food Fishes," gives us a very valuable paper upon this fish. And it is so replete with in-valuable practical, as well as historical facts, that we feel justified in giving it in full:

"THE BLUE-FISH."

Pomatomus Saltatrix.

Names.—This fish, which on the coast of New England and the Middle States is called the blue-fish, is also known in Rhode Island as the "horse mackerel"; south of Cape Hatteras as the "skipjack"; in North Carolina, Virginia, and Maryland it is said to be called the "green-fish." Young blue-fish are in some parts of New England called "snapping mackerel" or "snappers"; about New Bedford, "blue snappers"; to distinguish them from the sea bass they are sometimes spoken of as the "blue-fish." About New York they are called "skip mackerel," and higher up the Hudson River "white-fish."

In the Gulf of Mexico the name "blue-fish" is in general use.

Distribution.—This species is widely distributed — in the Malay Archipelago, Australia, at the Cape of Good Hope, at Natal and about Madagascar; in the Mediterranean, where it is a well-known and highly prized food fish in the markets of Algiers, though rare on the Italian side. It has been seen at Malta, at Alexandria, and on the coast of Syria, and about the Canaries. It has never been seen on the Atlantic coast of Europe, and, strangely enough, never in the waters of the Bermudas or any of the Western Islands. On our coast it ranges from Central Brazil and the Guianas through the Gulf of Mexico and north to Nova Scotia, though never seen in the Bay of Fundy. From Cape Florida to Penobscot Bay, blue-fish are abundant at all seasons when the temperature of the water is propitious. It is not known yet what limits of temperature are the most favorable to their welfare, but it would appear, from the study of the dates of their appearance during a period of years in connection with the ocean temperature, that they prefer to avoid water which is much colder than 40°. It is possible that the presence of their favorite food, the menhaden, has as much influence upon their movements as water temperature.

It is certain that few blue-fish are found on our Middle and Southern coast when the menhaden are absent; on the other hand, the blue-fish do not venture in great numbers into the Gulf of Main at the time when menhaden are schooling and are at their greatest abundance. Their favorite summer haunts are in the partially protected waters of the Middle States, from May to October, with an average temperature of 60° to 75°. The menhaden, or certain schools of them, affect a cooler climate and thrive in the waters of Western and Central Maine in the months when the harbor temperatures are little above 50° and 55°, and that of the ocean considerably lower."

Professor Baird has published in the First Report of the United States Fish Commission an exhaustive account of the habits of the blue-fish which will be quoted from freely in this chapter.

The presence of quotation marks will be sufficient to indicate the source of the paragraphs taken from his essay, without further reference to his name.

"*Movements and Migrations.*—The blue-fish is preeminently a pelagic or wandering fish, and like many others, especially of the *scrombridæ*, is apparently capricious in its movements, varying in numbers at particular localities with the year, and sometimes disappearing from certain regions for a large fraction of a century, again to return as before. The cause of this variation it is impossible to explain, being due in some instances, probably, to the disappearance of its favorite food in consequence of its own voracity, or for other undetermined reasons.

"They occur during the summer throughout the entire range indicated for the United States, but are much larger in size and in greater abundance from the coast of New Jersey northward. From New Jersey southward, in the season mentioned, with the exception of an occasional wandering school, they are generally only about eight to twelve inches in length, representing, therefore, in all probability, individuals of the second year's growth.

"They appear to have a regular migration along our coast, presenting themselves later and later in the spring, the farther they are found to the north, and disappearing in the inverse order from the same regions in the autumn. First noticed on the Carolina coast as early as March and April, immense schools of them, bound eastward, are seen off the coast of the Middle States from the middle of May to the middle of June,[1] and in October similar bodies, perhaps embracing fewer individuals, pass to the southward. It is possible, however, that in the autumn some schools move well out to sea, and are, therefore, less likely to be observed. They leave the northern coast about the middle of October, and about the middle of November appear in vast numbers off the coast of North Carolina, where, from Nag's Head, in Currituck County. to Cape Lookout, there is a very extensive fishery prosecuted, which furnishes blue-fish for the northern markets. It is estimated that at least one hundred and fifty crews are engaged in this fall fishing, which lasts generally until late in December. At this time individuals may be taken weighing fifteen to eighteen pounds, although their average size is about ten.

"Their occurrence in autumn off the coast of North Carolina is preceded and first indicated by the vast schools of menhaden, which they follow in, several miles from the sea, and by the usual accompaniment of flocks of gulls attending them to take a share in the feast. Of the particular mode of fishing in this neighborhood we shall take occasion to speak hereafter.

"According to Dr. Yarrow the blue-fish are seen in spring on the North Carolina coast (the smaller ones first) in March or April, when, however, they are much less in size than the specimens referred to as occurring in the fall. The precise time of their appearance at most of the points farther north has not yet been ascertained. Whether they actually migrate from south to north, and *vice versa*, or merely come in from the outer seas in regular order, as is believed to be the case with the shad, etc., has not been settled, although the former supposition appears the most probable. They reach the New Jersey coast sometime in the early part of May, and usually appear at Newport and in Vineyard Sound (the time varying with the season) from the middle of May to the first week in June. They are expected at Edgartown from the 25th to the 30th of May; but I am informed that, on their first arrival they feed at the bottom, and sometimes for a while are not seen at the surface at all, seldom being taken with the hook, but caught in large numbers in pounds and with gill-net, usually along the lower edge of the net. According to Dr. Yarrow, they are not taken with the hook about Beaufort until about the 1st of July.

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[1] In the Chesapeake, according to Dr. Wilkins, at Hunger's Wharf, Virginia, the tayler is one of the most abundant fish, as many as four thousand being caught at one lift of the pound. The average size is about three pounds. They come about the first of June and leave early in October.

They do not bite, however, in Vineyard Sound until from the 10th to the 15th of June, when they appear on the surface, and are caught in large numbers in the usual manner."

In the first week of May, 1878, about a thousand blue-fish, weighing four pounds each, were caught off Long Island at Canarsie and West Hampton. This is about two months earlier than is usual for them to be taken in any considerable numbers.

"*Periodicity.*—Great interest attaches to this fish in consequence of the changes in its abundance, and even its actual occurrence on our coast, within the historic period. The precise nature and extent of the variation has not been established, nor whether it extended along the entire coast or not. Its earliest mention for our waters is in the work of Josselyn ('New England Rarities Displayed,' 1672,) where, on page 96, he mentions the 'blew-fish, or horse,' as being common in New England (his residence was on the New Hampshire coast, or near by in Maine,) and 'esteemed the best sort of fish next to rock-cod.' He says: 'It is usually as big as the salmon, and a better meat by far.' He also, on page 24, catalogues two kinds of 'blew-fish' or 'hound-fish'; the 'speckeled hound-fish' and the 'blew hound-fish, called horse-fish.'

"There appears no species to which this reference could apply except the subject of our present article, this being the opinion of Mr. J. Hammond Trumbull, who has devoted much research to determining the modern equivalents of ancient Indian names of animals, and to whom I am indebted for the hint. Mr. Trumbull also remarks that in a manuscript vocabulary obtained by President Stiles, in 1762, from a Pequod Indian at Groton, Connecticut, there is mentioned the 'Aquaundunt or blue-fish,' clearly the same as what now bears that name, which shows that this fish was found in Fisher's Island Sound in 1762.

"Again, according to Zaccheus Macy[1], the blue-fish were very abundant about Nantucket from the first settlement of the English on the island, in 1659 to 1763, and were taken in immense numbers from the 1st of June to the middle of September. They all disappeared however in 1764, a period of great mortality among the Indians of that island. It has been suggested that the disease which attacked the Indians may have been in consequence of an epidemic in the fish upon which they fed, or else that it invaded both fish and Indians simultaneously, resulting in almost their entire extermination.[2]

"According to Dr. Mitchell, this fish was entirely unknown about New York prior to 1810; but they began to be taken in small numbers about the wharves in 1817, and were abundant in 1825.

Immense numbers were caught at the Highlands in 1841. The doctor remarks, as has been done repeatedly by others, that as the blue-fish increase, the squeteague or weak-fish diminished in about the same ratio.

"According to Mr. Smith, of Newport (Rhode Island), his father used to catch blue-fish some time about the year 1800, when they were abundant and of large size, weighing from sixteen to eighteen pounds.

"Captain Francis Pease, of Edgartown, also testified that his father spoke of large blue-fish at the end of the preceding century, some of them weighing forty pounds. This leaves an interval between 1764 and toward the end of the century in which no mention is made of the blue-fish, and which may probably indicate its absence, as during that time there were many works published relating to the local history and domestic economy of New England, and which would doubtless have taken note of so conspicuous a fish had it been present.

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[1] Collections Massachusetts Historical Society for 1794, iii., 1810.

[2] "From the first coming of the English to Nantucket (1659) a large fal-fish, called the blue-fish, thirty of which would fill a barrel, was caught in great plenty all round the island from the first of the sixth month (June) till the middle of the ninth month (September). But it is remarkable that in the year 1764 . . . they all disappeared, and that none have ever been taken since. This has been a great loss to us."—Ibid., 1792, p. 159. Zaccheus Macy's Account of Nantucket.

"Whether they existed uninterruptedly during the century intervening between Josselyn's time 1672 (or even 1659, according to Macy) and 1764, I am at present unable to say. According to Captain Pease, they were known about Edgartown at the end of the last century.[1] As already stated, Mr. Mitchell speaks of their first making their appearance in New York about 1810. They are noted as having been seen in Vineyard Sound again as early as 1820. It would therefore appear that they were in such small numbers about New York in 1810 that the young only were noticed flocking about the wharves, and that in ten years they were observed as far east as Nantucket, where the specimens seen from 1824 to 1826 were very small, not over four inches. The next year they measured seven and the third year ten inches, according to the testimony of one witness, although this does not represent, in all probability, the rate of growth.

"According to Captain Burgess, of Monument, Massachusetts, they were caught about Nantucket in 1825, and were very abundant in 1830. Dr. Storer states the first blue-fish recorded as having been noticed in the present century north of Cape Cod was captured on the 25th of October, 1837. Captain Atwood remarks that in 1838 he saw blue-fish for the first time about Provincetown. These were very small, the largest weighing only two pounds. In a few years, however, they became larger and more numerous, and finally increased to such an extent as to exercise a very marked influence upon the fisheries. According to the captain (Proceedings of Boston Society of Natural History,

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[1] President Dwight bears witness to the fact that blue-fish were abundant in the Narragansett Bay region as late as 1780. "The mackerel formerly frequented this coast in immense numbers, and in the season were constantly to be found in the market. But about the close of the Revolutionary War they forsook our waters and have not made their appearance since. They were esteemed a great delicacy, and are the largest of the mackerel species."—Note on Fishes of Newport, Rhode Island. Dwight's Travels, iii., 1822, p. 50.

1863, p. 189,) they arrive in Massachusetts Bay in a body, coming at once, so as to almost fill the harbor at Provincetown. In one year they came in on the 22d of June, and although the day before eight thousand mackerel were taken, the day after not one was seen or captured.

He says that they leave about the last of September, with the first cold northeasterly storm, although stragglers are taken as late as December at Provincetown.

"According to Messrs. Marchant and Peter Sinclair, of Gloucester, (October, 1872,) blue-fish made their first appearance in numbers about Cape Ann twenty-five years ago, coming in great force and driving out all other fish. They are now scarcer than twenty years ago; about the same as tautog; some seasons scarcely noticed.

"Mr. J. C. Parker, an aged gentleman of Falmouth, says the first blue-fish seen at Wood's Holl in this century was taken in July, 1831; but his father informed him that they were abundant in the preceding century, about 1780 or 1790, at which time they disappeared; and that when the blue-fish left, the scup first made their appearance. They are also noted as having shown themselves at the head of Buzzard's Bay in 1830 and 1831, and, although numerous, were of small size, measing about a foot in length.

"To sum up the evidence, therefore, in regard to the periodical appearance of the blue-fish, we find notice of its occurrence in 1672, or even 1659, and up to 1764. How long it existed in the waters prior to that date cannot now be determined. The oral testimony of Mr. Parker refers to its occurrence at Wood's Holl in 1780 or 1790; and it is mentioned by Mr. Smith as being at Newport in 1800, and at Edgartown, Massachusetts, about the same time by Captain Pease. Mitchell testifies to its occurrence in New York, of very small size, in 1810; and it is recorded as existing again at Nantucket in 1820, and about Wood's Holl and Buzzard's Bay in 1830 to 1831; and a little later at Hyannis.

In 1830 it had become abundant about Nantucket, and in the fall of 1837 it was first noticed in Massachusetts Bay; and then year by year it became more and more numerous, until now it is very abundant. Several accounts agree in reference to the very large size (even to forty or fifty pounds) of those taken in the last century.

" Further research into ancient records may tend to throw more light on the early history of the blue-fish, and even materially to change the conclusions already reached. It will be observed that the references to its occurrence, from 1780 to 1800, are on the testimony of aged persons who have heard their fathers speak of it, although I find no printed records anywhere in reference to it between 1764 and 1810. The rate of progression to the north of Cape Cod I have at present no means of indicating, although they probably gradually extended farther and farther north, and may possibly occur much farther east than we have any mention of at present.

" During the present century the maximum of abundance of these fish off the middle coast of the United States appears to have been reached from 1850 to 1860. The testimony elicited from various parties, as well as from printed records, indicates a decrease since that period much greater in some localities than others. About New York they are said to have been unusually plenty in the summer of 1871, but farther East the diminution which had been observed in previous years appeared to continue."

Since the writing of the above, in 1871, there has been no special change in the abundance of blue-fish. They are quite sufficient in number to supply the demand for them and to make great inroads upon the other fishes, some of which, like the menhaden and mackerel, would perhaps, if undisturbed by the blue-fish, be more valuable than they are at present. They have now been with us for fifty years. Their numbers are subject to periodical variation, of the cause of which we are ignorant. It is to be regretted that there are no records of it in the South Atlantic States. If such existed, we might, perhaps, learn from them that the blue-fish remained in those waters while absent from the northern coasts. Only one statement is to be found which covers this period, although Lawson, in his " History of North Carolina," published in 1709, and Gatesby, in his " Natural History of the Carolinas," published in 1743, refer to its presence. In "Bertram's Travels," published in 1791, "skipjack" is mentioned as one of the most abundant fish at the mouth of the St. John's River.

When blue-fish again became abundant their presence was first noticed at the South, and they seem to have made their inroads from that direction. The blue-fish was unknown to Schoepf, if we may judge from his work on the "Fisheries of New York," published in 1787. Dr. Mitchell recorded their frequent capture about New York in 1814, though before 1810 they are said to be unknown in that locality. In 1825 they were abundant here, and in 1841 immense numbers were captured in the Vineyard Sound, and about Nantucket they were on the increase from 1820 to 1830. It is certain that they had not reappeared in 1822 in Narragansett Bay, for in "Bertram's Travels" it is stated that, though formerly abundant, they had not been seen in that region since the time of the Revolution.

The first one which was noticed north of Cape Cod was captured in October, 1837, while we have no record of their appearance about Cape Ann before 1847.

Food and Voracity.—The blue-fish is a carniverous animal of the most pronounced type, feeding solely upon other fish. In this connection it cannot be out of place to reprint Professor Baird's remarks upon this subject, which have been so often quoted during the past ten years:

"There is no parallel in point of destructiveness to the blue-fish among the marine species on our coast, whatever may be the case among some of the carniverous fish of the South American waters. The blue-fish has been well likened to an animated chopping machine, the business of which is to cut to pieces and otherwise destroy as many fish as possible in a given space of time.

All writers are unanimous in regard to the destructiveness of the blue-fish. Going in large schools, in pursuit of fish not much inferior to themselves in size, they move along like a pack of hungry wolves, destroying everything before them. Their trail is marked by fragments of fish and by the stain of blood in the sea, as, where the fish is too large to be swallowed entire, the hinder portion will be bitten off and the anterior part allowed to float away or sink. It is even maintained, with great earnestness that such is the gluttony of the fish, that when the stomach becomes full the contents are disgorged and then again filled. It is certain that it kills many more fish than it requires for its own support.

"The youngest fish equally with the older, perform this function of destruction, and although they occasionally devour crabs, worms, etc., the bulk of their sustenance throughout the greater part of the year is derived from other fish. Nothing is more common than to find a small blue-fish of six or eight inches in length under a school of minnows making continual dashes and captures among them. The stomachs of the blue-fish of all sizes, with rare exceptions, are found loaded with the other fish, sometimes to the number of thirty or forty, either entire or in fragments.

"As already referred to, it must also be borne in mind that it is not merely the small fry that are thus devoured, and which it is expected will fall a prey to other animals, but that the food of the blue-fish consists very largely of individuals which have already passed a large percentage of the chances against their attaining maturity, many of them, indeed, having arrived at the period of spawning. To make the case more clear, let us realize for a moment the number of blue-fish that exist on our coast in the summer season. As far as I can ascertain by the statistics obtained at the fishing stations on the New England coast, as also from the records of the New York markets, kindly furnished by Middleton & Carman, of the Fulton Market, the capture of blue-fish, from New Jersey to Monomoy, during the season, amounts to not less than one million individuals, averaging five or six pounds each. Those, however, who have seen the blue-fish in his native waters, and realized the immense number there existing, will be quite willing to admit that probably not one fish in a thousand is ever taken by man. If, therefore, we have an actual capture of one million, we may allow one thousand million as occurring in the extent of our coasts referred to. even neglecting the smaller ones, which, perhaps, should also be taken into the account.

"An allowance of ten fish per day to each blue-fish is not excessive, according to the testimony elicited from the fishermen, and substantiated by the stomachs of those examined; this gives ten thousand millions of fish destroyed per day. And as the period of the stay of the blue-fish on the New England coast is at least one hundred and twenty days, we have in round numbers twelve hundred million millions of fish devoured in the course of a season.

"Again, if each blue-fish, averaging five pounds, devours or destroys even half its own weight of other fish per day (and I am not sure that the estimate of some witnesses of twice this weight is not more nearly correct), we will have, during the same period, a daily loss of twenty-five hundred million pounds, equal to three hundred thousand millions for the season.

"This estimate applies to three or four year old fish, of at least three to five pounds in weight. We must, however, allow for those of smaller size, and a hundred fold or more in number, all engaged simultaneously in the butchery referred to.

"We can scarcely conceive of a number so vast; and however much we may diminish, within reason, the estimate of the number of blue-fish and the average of their captures, there still remains an appalling aggregate of destruction. While the smallest blue-fish feed upon the diminutive fry, those of which we have taken account capture fish of large size, many of them if not capable of reproduction, being within at least one or two years of that period.

"It is estimated by very good authority that of the spawn deposited by any fish at a given time not more than thirty per cent. are hatched, and that less than ten per cent. attain an age when they are able to take care of themselves. As their age increases, the chances of reaching maturity become greater and greater. It is among the small residuum of this class that the agency of the blue-fish is exercised, and whatever reasonable reduction may be made in our estimate, we cannot doubt that they exert a material influence.

"The rate of growth of the blue-fish is also an evidence of the immense amount of food they must consume. The young fish which first appear along the shores of Vineyard Sound, about the middle of August, are about five inches in length. By the beginning of September, however, they have reached six or seven inches, and on their reappearance in the second year they measure about twelve or fifteen inches. After this they increase in a still more rapid ratio. A fish which passes eastward from Vineyard Sound in the spring, weighing five pounds, is represented, according to the general impression, by the ten to fifteen pound fish of the autumn.

If this be the fact, the fish of three or four pounds which pass along the coast of North Carolina in March return to it in October weighing ten to fifteen pounds.

"As already explained, the relationship of these fish to the other inhabitants of the sea is that of an unmitigated butcher; and it is able to contend successfully with any other species not superior to itself in size. It is not known whether an entire school ever unite in an attack upon a particular object of prey, as is said to be the case with the ferocious fishes of the South American rivers; should they do so, no animal however large, could withstand their onslaught.

"They appear to eat anything that swims of suitable size—fish of all kinds, but perhaps more especially the menhaden, which they seem to follow along the coast, and which they attack with such ferocity as to drive them on the shore, where they are sometimes pilled up in windrows to the depth of a foot or more.

"The amount of food they destroy, even if the whole of it be not actually consmmed, is almost incredible. Mr. Westgate (page 33) estimates it at twice the weight of the fish a day, and this is perhaps quite reasonable. Captain Spindle goes so far as to say that it will destroy a thousand fish a day. This gentleman is also of the opinion that they do much more harm to the fishes of the coast than is caused by the pounds. They will generally swallow a fish of a very large size in proportion to their own, sometimes taking it down bodily; at others, only the posterior half. The peculiar armor of certain fish prevents their being taken entire; and it is not uncommon to find the head of a sculpin or other fish, whose body has evidently been cut off by the blue-fish. In the summer time the young are quite apt to establish themselves singly in a favorite locality, and, indeed, to accompany the fry of other fishes, usually playing below them, and every now and then darting upward and capturing an unlucky individual, while the rest dash away in every direction. In this manner they attend upon the young mullet, atherinas, etc. They are very fond of squid, which may very frequently be detected in their stomachs.

In August, 1870, about Fire Island, Mr. S. I. Smith found their stomachs filled with marine worms, a species of heteronereis, which, though usually burrowing in the mud, at that season swims freely toward the surface in connection with the operation of reproduction. This, like the squid, is a favorite bait for the bluefish, and they appear to care for little else when these are to be had. This fact probably explains the reason why, at certain seasons, no matter how abundant the fish may be, they cannot be taken with the drail or squid bait."[1]

The blue-fish are believed to have had a very important influence upon the abundance of other species on some parts of the coast. This has been noticed especially on the north side of Cape Cod. South of Cape Cod the small fish occur in such numerous abundance that even the voracity of millions of blue-fish could hardly produce any effect upon them. Captain Atwood has recorded his belief that the advent of the blue-fish drove away the plaice or large flounder from those waters, not so much by their direct attacks upon them as by destroying the squid upon which the latter formerly subsisted. He is also of the opinion that the mackerel once, for a time, were affected by them. The mackerel have since returned to those waters in their wonted numbers, but the blue-fish are not sufficiently plenty north of Cape Cod to interfere with them. The flight of the mackerel was not an unmitigated evil, however, since as Captain Atwood pointed out, the number of lobsters for a time was very considerably increased. The mackerel fed upon their eggs, and when they were driven away by the blue-fish the lobsters had a better chance to multiply.

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[1] The following extract from the "Gloucester Telegraph" of June 4, 1870, gives an idea of their influence upon other fishes:

"ABUNDANCE OF FISH IN NEW JERSEY—1870.—Accounts from New Jersey say that the blue-fish came in at Barnegat Inlet last week, sweeping through the bay, over flats as well as through the channel, driving millions of bushels of bunkers before them and filling the coves, creeks, ditches and ponds in the meadows full. At Little Egg Harbor Inlet they drove shad on shore so that people gathered them up by wagon-loads. Fish lie in creeks, ponds, etc., along the meadows two feet deep, so that one can take a common fork and pitch them into a boat or throw them on the bank. In some places they lie in windrows on the meadows where the tide has taken them, so they take large wood-scows alongside and load them."

1857.—"Blue-fish were very plenty off our shores in the early part of autumn. They are great enemies to the menhaden; and for several days such a war raged that the beaches were strewn with dead fish, chiefly of the latter species. Mr. Lewis, the historian, said that in two tides he picked up nine bushels and buried them in his garden for manure."—Lewis and Newhall, p. 452, History of Lynn.

"The blue-fish sometimes make their way up the rivers to a considerable distance, the adults, however, apparently never entering the perfectly fresh water. They are found in the Potomac as far north as Aquia Creek, and also far up the Hudson; indeed, the young of the year are taken as high as Sing Sing on the Hudson, and other tidal rivers, where the water is entirely fresh."

Reproduction.—"Little is known of their reproduction. Dr. Yarrow does not give any facts in regard to this subject, at Fort Macon, except that spawn was seen to run out of a small female caught July 14. Dr. Holbrook is also silent on this head.

Mr. Genio C. Scott, says the spawning beds are visited by the parent in June, and consist of quiet nooks or bays. Mr. R. B. Roosevelt states that very diminutive young occur in immense numbers along the coast at the end of September or beginning of October ('Game Fish of America,' 1862, 159). I found the young fish at Carson's Inlet, Beasley's Point, New Jersey, 1854, two or three inches in length, and more compressed than the adult; but farther east, on Vineyard Sound, although diligent search was conducted between the middle of June and the first of October, with most efficient apparatus in the way of fine-meshed nets, I met with nothing excepting fish that made their appearance all at once along the edge of the bay and harbor.

"According to Captain Edwards, of Wood's Holl, a very accurate observer, they have no spawn in them when in Vineyard Sound. This statement is corroborated by Captain Hinckley; and Captain Hallet, of Hyannis, 'does not know where they spawn.' The only positive evidence on this subject is that of Captain Pease, who states it as the general impression about Edgartown that they spawn about the last of July or the first of August. He has seen them when he thought they were spawning on the sand, having caught them a short time before, full of spawn, and finding them afterwards for a time thin and weak. He thinks their spawning ground is on the white sandy bottom to the eastward of Martha's Vineyard, toward Muskeegut. While not discrediting the statement of Mr. Pease, it seems a little remarkable that so few persons on the eastern coast have noticed the spawning in the summer of the blue-fish; and although there may be exceptions to the fact, it is not impossible that the spawning ground is in very early spring, or even in winter, off New Jersey and Long Island or farther south. It is not impossible that, at a suitable period after spawning, the young, in obedience to their migratory instinct may move northward along the coast, growing rapidly as they proceed. This explains the almost sudden appearance of fish of five inches about Wood's Holl.

"We have the statement of Dr. Yarrow that vast schools of small blue-fish were met in Beaufort Harbor during the last week in December, 1871. These were in company with small schools of young menhaden and yellow-tail shad, and were apparently working their way toward the sea by the route of the inlet. When observed they were coming from the southward through the sound, moving very slowly, at times nearly leaving it, and then returning.

The largest were about four inches in length, and others were much smaller; and as many as twenty schools were observed from the wharf at Fort Macon, each of them occupying an area of from sixty to eighty feet square, and apparently from four to six feet in depth. I would not be much surprised if these fish should prove to have been spawned late in the year off the southern coast."

Dilligent search by numerous inquirers during a period of ten years has failed to add anything of importance to what Professor Baird has already stated in the paragraph above quoted, and it may be regarded as almost certain that blue-fish do not spawn in our inshore waters. The only important contribution to our knowledge on this subject is found in the notes of Mr. Silas Stearns, who believes that he has abundant evidence of their spawning in the Gulf of Mexico. His remarks are quoted in full below. The Hon. Robert B. Roosevelt records that he observed the blue-fish fry less than an inch in length in the inlet of Far Rockaway, New York, on the 10th of July.

Size.—"The size varies considerably with season and locality, those spending the summer on the southern coast, according to good authority, rarely exceeding two or three pounds in weight, and being generally considerably less. The largest summer specimens are those found farther to the eastward, where they are not unfrequently met with weighing from ten to fifteen pounds, although this latter weight is quite unusual. Mr. Snow, however, (page 44) mentions having seen one of twenty-two pounds, and others give as their maximum from fourteen to twenty. The average size of the schools in Vineyard Sound, during the early season, is from five to seven pounds. The schools, however, that make their appearance in October embrace many individuals of from ten to fifteen pounds.

It is, therefore, not improbable that the difference between the first mentioned average and the last represents the increase by their summer feeding. As already remarked, blue-fish in the last century sometimes attained a weight of forty or fifty pounds in Vineyard Sound; according to Zaccheus Macy, thirty of them would fill a barrel."

"Forest and Stream," June 25, 1874, states that L. Hathaway, Esq., a veteran fisherman, while fishing from the bridge at Cohasset Narrows, Massachusetts, with rod and reel, captured a blue-fish weighing twenty-five pounds. The largest previously caught weighed seventeen pounds.

"On getting back to the Carolina coast in the early part of November, according to Dr. Yarrow's statement, they are from three to five feet in length and weigh from ten to twenty pounds. What becomes of these large fish, that so few of them are seen in the early spring, it is impossible to say. If it be really true that they are much scarcer than in the fall, we may infer that their increased size makes them a more ready prey to the larger fish and cetaceans, or that they have accomplished their ordinary period of life; possibly that they have broken up into smaller parties, less conspicuous to observation, or that they have materially changed their locality. The average length of the fish that appear in the spring off the coast of Virginia and the southern part of New Jersey, according to Dr. Coues, Dr. Yarrow, and my own observation, is about one foot, being probably about one year old.

As a general rule, those of the smaller size keep close to the shore and can always be met with, while the larger ones go in schools and remain farther outside.

"I was unable to obtain any very young fish about Wood's Holl in 1871, the smallest found making their appearance quite suddenly along the coast, especially in the little bays, about the middle of August, and then measuring about five by one and one-fifth inches. By the end of a year they probably constitute the twelve or fifteen inch fish referred to as occurring along the southern coast. The fish of the third year, or those two years old, are possibly the three-pound fish, while the five to seven pound fish may be considered a year older still. Accurate observations are wanting, however, to determine these facts; as also whether they require two years, or three or more, to obtain sufficient maturity for breeding. As far as I know, there is no appreciable difference between the sexes in their rate of growth or weight, excepting that the female is likely to be a little deeper in the body."

A blue-fish weighing one pound measures about fourteen inches; two pounds, seventeen inches; three pounds, twenty-one inches; four pounds, twenty-four inches; five pounds, twenty-six inches; six pounds, twenty-six to twenty-seven inches, and eight pounds, twenty-nine inches.

Stearns on Blue-fish in the Gulf of Mexico.—Mr. Stearns' notes on the occurrence of the blue-fish in the Gulf of Mexico are so important that they are quoted in full;

"The blue-fish is abundant in West Florida and as far west as the Mississippi river, but is rare or not found at all in other parts of the Gulf. At Pensacola and vicinity it is at certain seasons one of the most important fishes of trade. Here it is caught only in seines and when migrating, during the months of April, May, June, November and December. It usually appears on the coast in April—sometimes a little sooner—and comes from the northeast, swimming directly in from deep water, or parallel to the land, according to the condition of the sea. It sometimes swims near the surface, either to sport or prey upon smaller surface-swimming fishes, but more commonly at some depth in shoal water along the beach. Many schools are observed through the months of April, May and June approaching the land from the eastward, and it is supposed that there are several distinct 'runs' in that period. These 'runs' take place every year, although much larger some years than others. It is usually the case that the fish arriving in the spring are small, averaging two and a half pounds weight, and that those caught in the fall are larger, averaging four pounds or more. A few very large individuals are found in both seasons.

"In May and June blue-fish enter the bays. They remain for some days in the swift tideways when inside, and then disappear almost entirely from observation. A few are taken through the summer with hook and line in the bays and at sea. Excepting the smallest ones, all the blue-fish contain spawn when they arrive in the spring. With the larger fish the spawn is nearly ripe, and with the small and intermediate size is found in nearly all stages.

April 29, 1879, I examined two female blue-fish, weighing seven and eight pounds, and found spawn almost ripe enough to flow from the oviduct. The same day others, smaller ones, were examined, in which the ovaries were scarcely visible. The spawning season of the blue-fish includes several months, I think, which are May, June, July, and August.

"There can be no doubt of its spawning in the bays, sounds, and bayous, as all evidence gained goes so far to prove it. On June 18, 1878, and August 9, 1878, I caught young blue-fish of about three-quarters of an inch in length in Pensacola Bay. These fry were very active and gave me no little trouble in capturing them.

Their color was a brilliant green, which faded considerably when placed in alcohol. These, with others, were sent to the National Museum with my collections of that year. Many other specimens of about that size were seen in August, but escaped my net. During the months of November and December many small schools of blue-fish are seen to pass out of the inlets, and, if there is not much surf, to follow along the beach eastward. Blue-fish of all sizes may be seen at this time, the smaller ones measuring in length three to five inches, the intermediate sizes, ten, twelve, and fifteen inches, and the large ones from the last-mentioned size to a size weighing fifteen to eighteen pounds. Ten pounds is not an unusual weight for large blue-fish, but those of eighteen pounds are rare.

Blue-fish are said to be more abundant on this coast than formerly, and any change in the last five years has tended to an increase rather than a decrease. It is an exceedingly voracious fish, preying upon any kind of fish through which its teeth can cut and which its jaws can surround. I think its migratory movement on this coast is caused more on account of its food becoming scarcer in cold weather than on account of its being influenced by the change of the temperature of the water. For on the coldest days of the year (in December) blue-fish are sometimes caught in shoal water in great abundance as well as at any other time. The blue-fish is one of the choicest food fishes of this coast, and is much used, both fresh and salted."

Earll on the Blue-fish in North Carolina.—Below is given an outline of the winter blue-fish fisheries of the Southern coast as gathered from notes made during the visit of Mr. R. E. Earll to that region:

The large fish are taken in two localities—first, a few miles off Cape May, and again on the Carolina coast between Cape Henry and Ocracoke Inlet. They are most abundant between Cape Hatteras and New Inlet. Small fish frequently enter the sounds during the summer months, and have long been taken by the residents. The larger ones seldom enter the inlets, but remain near the outer shore, where they feed upon the menhaden, shad and alewives, during the season of their migrations to and from the large sounds in fall and spring.

"Apparently, the first that was known of large blue-fish in this region was in 1842, when a quantity was taken in a haul-seine near New Inlet. Gill-nets were first used for the capture of the species in this locality in 1847, though they were not generally adopted till several years later. The first vessel visited the region in 1866, and from that date to 1879, six to twelve sails came regularly to that locality. The fishery reached its height between 1870 and 1876, when in addition to the vessels fully one hundred crews of five men each fished along the shores. The catch varies greatly from time to time, as the fish are constantly on the move and often go beyond reach of the seines and gill-nets.

Some seasons each boat's crew has averaged four or five thousand fish weighing ten to fifteen pounds each. And again they have taken almost nothing. Frequently the bulk of the catch of an entire season is taken in three or four days.

Since the winter of 1877 and 1878 the fish are said to have been much less abundant and of smaller size. In the winter of 1879 and 1880 about seventy-five crews were engaged in the fishery from the first of November till Christmas. The total catch did not exceed fifty thousand fish, averaging six pounds each. The small number taken is partially accounted for by the fact that many of the fish were so small as to readily pass through the meshes without being caught.

During my visit in May, 1880, large schools of blue-fish were reported along the shore, and a considerable number of shad and other species were found upon the beach where they had been driven by their pursuers. A good many blue-fish were also stranded while in pursuit of their prey. It seemed that there is no reason to believe that the fish have permanently left the coast, or that they are even so scarce as is at present claimed, for the men have fished with little regularity, and have gone only a short distance from the shore, while the bulk of the blue-fish may have been farther out.

Uses.—This is one of the most important of our food fishes, and surpassed in public estimation only by the Spanish mackerel and the pompano. It may be said to furnish a large part of the supply to the Middle and Northern States. It is a standard fish in New York, Boston and other seaports, and is carried in great numbers into the interior. Its flesh is very sweet and savory, but it does not keep very well. In the Vineyard Sound the fishermen are in the habit of crimping their fish, or killing them by cutting their throats in such a manner that they bleed freely. Everyone who has opportunities for observing admits that fish thus treated are far superior to any others. Great quantities of blue-fish are frozen in New York for winter consumption. They are still considered unfit for food on our Southern coast, and even in the markets of Washington, District of Columbia, I have frequently been stopped by fish-dealers who asked me to assure their customers that blue-fish were eatable. They are growing into favor everywhere, however, just as they did in Boston. Captain Atwood tells that in 1865 but very few were sold in Boston, and that the demand has been increasing ever since. When he first went to Boston with a load of blue-fish he got two cents a pound for them; the second year they were scarcer and he got two and one-half cents, and the year afterwards three cents."

These fish have the last season been plenty all along the coast, and, at times so very plenty that they have been sold as low as one cent a pound. An instance is reported to us where the captain of a smack declined a load offered as a gift, he having just left New York, where there was no market for them.

There has been good fishing all the season.

BASS.

The past season has been an exceptionally good one. If this fish has not been so plenty as at some former times, the fishing has been very good, and the sportsmen have made good catches. The fish have been large. We hear of two gentlemen who caught seven hundred pounds in two days, and quite a number were taken ranging from forty to fifty-seven pounds.

TAUTOG.

There has been, we think, a very decided increase in this valued local fish, and reports come to us of good fishing for them in the fishing grounds in the bay.

HERRING

Did not appear as usual in the lower waters of the bay, but were plenty in the Taunton River. The traps that in years past caught thousands caught but very few.

FLAT-FISH.

These fish, that have usually been very plenty in Seaconnet river, failed to appear there in any considerable numbers; but we learn were plenty at Cole's river and other places.

MENHADEN.

These fish came to our coast about the middle of May in small schools, and the fishing was light all that month. In June they were here in large bodies and there was good fishing. Later on they moved eastward, and by the last of June were in Boston Bay.

From there the fishing was transferred to the coast of Maine until the last of September, when they again came south, and by the 21st of October were very plenty off our coast, but a heavy storm prevailed from the 23d to the 29th, after which none were to be found. They next appeared in immense schools off Barnegat, going south at the rate of one hundred miles a day.

The season closed about three weeks sooner than usual.

The catch of menhaden by our fleet was as follows:

Steamer	G. W. Humphreys	60,000	barrels.
"	A. M. Hathaway	49,000	"
"	Joseph Church	45,000	"

Steamer George Curtis	45,000	barrels.
“ Cora P. White	32,000	“
“ Fannie Sprague	27,000	“
“ Wm. Wells	19,000	“
“ Seven Brothers	16,000	“
Schooner Antelope	18,000	“
Steamer Walter Adams	50,000	“
“ Mabel Bird	53,000	“
“ George Morse	40,000	“
“ Seaconnnet	36,509	“
“ Fearless	31,000	“
Schooner Dragonett	1,748	“
“ Penekese	3,038	“
Steamer Kingfisher	32,000	“
Received at Oil Works from other sources	1,800	“
	560,086	“

CATCH OF MENHADEN.

1886	232,471	barrels.
1887	175,667	“
1888	377,607	“
1889	508,482	“
1890	560,086	“

As expressed by the Commissioners in their last report, it is their earnest desire to make the report a correct and comprehensive account of all the fisheries of this State, and it is hoped that all who can will render such aid as they may towards accomplishing this end.

A correct account of the catches or any unusual occurrence will be thankfully received and appreciated.

While the Commissioners will spare no pains to collect information relating to the fisheries, they must depend upon the aid and cooperation of fishermen and others for statistics and other interesting matter relating to this subject.

We cordially invite all who have had personal observation or experience of special interest to correspond with us, and thus greatly add to the value and interest of the report.

State of Rhode Island in account with Commissioners of Inland Fisheries.

	Dr.	
1889.		
Dec. 31.	To Balance due Commissioners	$14 12
1890.		
April 19.	" Freight and express, gold fish	6 30
28.	" Brook trout eggs	55 98
	" Hatching and raising trout and salmon	31 13
	" Express on salmon and trout eggs	5 35
Dec 31.	" Stationery, stamps, envelopes, etc	16 25
	" Cans to transfer fry	9 00
	" Travelling expenses of Commissioners and expense distributing salmon and trout fry	61 86
		$199 89
	Cr.	
	By cash from State Treasurer	$199 89

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
Commissioners of Inland Fisheries.

29150

State of Rhode Island and Providence Plantations.

[22nd]

ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1892.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1892.

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REPORT.

To the Honorable General Assembly of the State of Rhode Island and Providence Plantations at its January Session, 1892:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1891.

SHAD.

The Commissioners of Inland Fisheries received from Col. Marshall McDonald, United States Fish Commissioner, two million sixty thousand (2,060,000) shad fry May 4th, 1891. These were deposited in Palmer river, which is the only stream in the State adapted to them, not having insurmountable dams or other obstructions.

TROUT.

We have purchased forty thousand (40,000) trout eggs, which were hatched and the fry has been placed in various streams of the State. The trout fishing the past season has not been as good as last year, owing in part to excessive fishing last year, and lower state of water.

The Bay and coast fisheries the past season has in some respects been peculiar; all along the coast the blue-fish and small mackerel have been abundant, while in the bay, scup, tautog, flat-fish and small mackerel have been present in large numbers.

The herring and the bass have failed to appear in numbers. The menhaden fishing has been very light. The catch is indicated in the table of shipments as follows.

The following table shows the amount of fish and lobsters shipped from Newport by the Old Colony Steamboat and Railroad for each month of the year 1891:

Month.	Fish.		Lobsters.	
January	23	Barrels.	44	Barrels.
February	51	"	48	"
March	61	"	62	"
April	288	"	227	"
May	12,174	"	236	"
June	3,010	"	317	"
July	1,072	"	542	"
August	610	"	401	"
September	353	"	265	"
October	268	"	24	"
November	100	"	5	"
December	22	"	33	"
Total	18,032	"	2,204	"

Total of fish and lobsters shipped from Newport by the Old Colony lines:

1886	17,434	Barrels.
1887	17,491	"
1888	16,194	"
1889	21,353	"
1890	11,583	"
1891	20,236	"

For further statistics of the fisheries of Rhode Island we copy from the Statistical Review of the Coast Fisheries, published by United States Commission, 1891.

RHODE ISLAND.

The tables presented show many phases of the fisheries not similarly exhibited in the statistics of 1880; it is difficult therefore to institute comparisons in all cases. There has been a large decrease in persons employed, amounting to 26 per cent , and an increase of 73 per cent. in capital invested and 18 per cent. in the catch. This is due to the improvement in the vessels, especially those employed in menhaden fishing, in the menhaden factories, and in the pound-net and trap fisheries. There is not much difference in the value of menhaden vessels ; in the aggregate fewer vessels are now employed, but these are of an improved type, and, with fewer men, perform the same work that was done by a larger fleet in 1880.

There has been a gratifying increase in the menhaden industry, the manufactured products of which in 1880 were valued at $221,748, while in 1888 the amount was $334,686. This is the most important fishery of the State, taking the value of the manufactured products as a basis, but is excelled by the oyster industry, if we consider only the amount paid to fishermen for their catch. With the exception of the menhaden industry, there is no important vessel fishery; the craft employed are generally small and engaged in shore or market fishing.

48. *Table of persons employed.*

How engaged.	1887.	1888.
On fishing vessels	364	400
On transporting vessels	14	17
On boats	915	875
On shore, in factories, etc	342	411
Total	1,635	1,703

49. *Table of apparatus and capital.*

Designation.	1887.		1888.	
	No.	Value.	No.	Value.
Vessels fishing *	55	$171,400	64	$194,150
Outfit	....	23,281	....	29,065
Vessels transporting †	7	2,550	9	3,225
Outfit	....	530	....	510
Boats	748	91,324	749	91,679
Apparatus of capture—vessel fisheries:				
Purse seines	17	10,950	17	10,800
Hand lines and trawl lines	....	1,750	....	1,555
Gill nets	3	30	9	90
Harpoons	20	300	32	480
Pots	175	350	225	450
Dredges, rakes, etc	72	919	75	975
Apparatus of capture—shore fisheries:				
Haul seines	42	2,900	42	2,900
Hand lines and trawl lines	....	180	....	179
Trap nets and pound nets	160	72,400	166	79,870
Fyke nets	354	2,570	374	2,670
Gill nets	99	6,270	96	6,090
Dredges, tongs, etc.	999	7,483	493	2,950
Pots	5,600	6,798	5,450	6,723
Miscellaneous apparatus	....	12	....	10
Shore property	....	348,264	....	353,485
Cash capital	....	242,500	....	235,000
Total	....	$992,761	....	$1,022,876

* Tonnage in 1887, 1,221.21; in 1888, 1,349.60.

† Tonnage in 1887, 105.30; in 1888, 131.91.

50. *Table of products.*

Species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Alewives	682,800	$10,250	666,800	$10,215
Alewives, salted	325,000	6,500	415,000	8,500
Alewives, smoked	130,000	2,250	150,000	2,450
Bluefish	321,650	22,305	388,850	23,140
Butterfish	266,000	9,820	283,000	9,810
Cod	204,394	6,499	253,250	7,653
Cod, salted	82,558	3,754	53,140	2,009
Eels	318,000	16,950	321,600	17,332
Flounders	426,300	11,406	558,000	13,290
Haddock	87,450	2,468	86,460	2,607
Haddock, salted	4,464	147	4,704	118
Kingfish	8,000	320	8,500	298
Mackerel	268,063	18,545	237,100	20,007
Mackerel, salted	500,200	28,541	303,800	28,624
Menhaden	34,035,000	85,088	78,269,800	195,277
Perch	61,000	2,440	60,000	2,400
Pollock, salted	50,960	1,752	50,400	1,800
Scup	3,030,033	75,545	4,207,700	84,480
Sea bass	497,800	13,090	512,400	15,504
Shad	16,700	1,247	17,400	1,213
Smelts	55,000	2,875	61,500	3,135
Squeteague	268,000	10,450	275,000	11,540
Striped bass	61,200	5,324	85,500	7,048
Swordfish	101,452	4,430	217,063	9,718
Tautog	182,000	7,200	187,450	7,608
Miscellaneous fish	83,545	1,289	122,861	1,677
Refuse fish	860,000	1,090	1,396,000	1,756
Lobsters	570,039	27,128	588,500	28,047
Crabs	4,800	1,200	4,000	1,000
Oysters	1,358,210	261,026	1,324,785	252,601
Clams (*Mya arenaria*)	258,250	25,030	308,250	30,030
Quohaugs (*Venus mercenaria*)	153,720	15,699	264,232	28,075
Scallops	11,284	2,337	4,942	1,130
Total	45,284,872	$683,495	91,687,487	825,092

51. *Summary by customs districts of the vessel fisheries of Rhode Island in 1887 and 1888.*

Designation.	Newport.		Bristol and Warren.		Providence.		Total.	
	1887.	1888.	1887.	1888.	1887.	1888.	1887.	1888.
Number and nationality of fishermen:								
Americans	300	330	10	14	48	56	358	400
All others	....	....	....	....	6	....	6	....
Total	300	330	10	14	54	56	364	400
Number and nationality of crews on transports:								
Americans	14	17	....	....	....	....	14	17
Number of vessels fishing	35	40	5	6	15	18	55	64
Number of vessels transporting	7	9	....	....	....	....	7	9
Net tonnage of vessels fishing	1,045.71	1,089.63	43.25	48.52	132.25	211.45	1,221.21	1,349.60
Net tonnage of vessels transporting	105.30	131.91	....	....	....	....	105.30	131.91
Value of vessels fishing	$155,100	$166,350	$2,900	$5,200	$13,400	$22,600	$171,400	$194,150
Value of vessels transporting	2,550	3,225	....	....	....	....	2,550	3,225
Value of outfit, gear, provisions, fuel, etc., of vessels fishing	34,555	37,785	475	1,225	2,550	4,425	37,580	43,435
Value of provisions, fuel, etc., of vessels transporting	530	510	....	....	....	....	530	510
Value of catch of vessels fishing	128,407	239,922	3,060	7,870	42,656	45,271	174,123	293,063
Value of products transported	12,400	13,840	....	....	....	....	12,400	13,840

52. *Table showing by apparatus and species the yield of the vessel fisheries of Rhode Island in 1887 and 1888.*

Apparatus and species.	1887.		1888.	
	Pounds.	Value.	Pounds.	Value.
Hand lines and trawl lines:				
Blue fish	12,150	$709	42,200	$1,962
Cod	133,894	4,329	180,250	5,408
Cod, salted	66,878	3,054	38,580	1,369
Haddock	80,950	2,313	80,460	2,462
Haddock, salted	4,464	147	4,704	118
Mackerel	43,063	3,545	29,300	2,637
Mackerel, salted	324,200	17,981	167,800	13,424
Tautog	... .	....	3,950	158
Total	665,599	$32,078	547,244	$27,528
Seines:				
Mackerel	....	....	4,000	360
Menhaden	34,035,000	85,088	78,269,800	195,277
Miscellaneous fish	7,045	141	4,361	97
Total	34,042,045	$85,229	78,278,161	$195,734
Gill nets:				
Bluefish	....	....	650	30
Mackerel	....	....	4,000	360
Scup	2,833	85	1,700	50
Total	2,833	$85	6,350	$440
Harpoons:				
Swordfish	101,452	$4,430	217,063	$9,718
Pots:				
Eels	....	....	4,100	$249
Lobsters	20,039	1,128	38,500	2,047
Total	20,039	$1,128	42,600	$2,203
Dredges and rakes:				
Oysters	239,710	$45,887	281,288	$53,645
Quohaugs	33,720	2,949	24,238	2,575
Scallops	11,284	2,337	4,942	1,130
Total	284,714	$51,173	310,468	$57,350
Grand total	35,116,682	$174,123	79,401,886	$293,063

53. *Table showing by fisheries and species the yield of vessel fisheries of Rhode Island in 1888.*

Fisheries and species.	Pounds.	Value.	Fisheries and species.	Pounds.	Value.
Shore:			Mackerel:		
Bluefish	42,850	$1,992	Mackerel	37,300	$3,357
Cod	180,250	5,408	Mackerel, salted	167,800	13,424
Cod, salted	38,580	1,359	Miscellaneous fish	4,361	97
Eels	4,100	246			
Haddock	80,460	2,462	Total	209,461	$16,878
Haddock, salted	4,704	118			
Scup	1,700	50	Mollusk:		
Tautog	3,950	158	Oysters	281,288	$53,645
			Quohaugs	24,238	2,575
Total	356,594	$11,793	Scallops	4,942	1,130
Swordfish	217,063	$9,718	Total	310,468	$57,350
Menhaden	78,269,800	195,277			
Lobster	38,500	2,047	Grand total	79,401,886	$293,063

54. *Table showing the number of vessels engaged in each fishery in Rhode Island in 1888, together with their tonnage, value, and number of crew.*

Fishery.	Number of vessels engaged.	Net tonnage.	Value of vessels.	Number of fishermen.*
Mackerel	30	375.95	$43,500	119
Menhaden	12	770.00	136,000	225
Shore	21	243.91	20,800	80
Swordfish	16	210.89	25,250	60
Crustacean	3	17.55	1,600	9
Mollusk	22	191.36	24,800	53

* All American citizens.

55. *Table showing by apparatus and species the yield of the shore fisheries of Rhode Island in 1887 and 1888, exclusive of the shellfish and crustacean fisheries.*

Apparatus.	Species.	1887.		1888.	
		Pounds.	Value.	Pounds.	Value.
Pound nets...........	Alewives....................	681,300	$10,230	664,800	$10,170
	Alewives, salted....	10,000	200	15,600	325
	Alewives, smoked.	80,000	1,250	95,000	1,552
	Bluefish......................	53,500	3,076	65,800	3,948
	Butterfish...................	262,000	9,240	277,700	9,704
	Eels....	75,000	3,000	111,000	5,994
	Flounders...	313,300	8,566	408,000	9,545
	Kingfish....	8,000	320	8,500	298
	Scup.................	3,027,200	75,460	4,206,000	84,430
	Sea bass	485,800	12,640	496,300	14,976
	Shad.........	7,500	562	8,400	588
	Smelt...................	40,000	2,000	42,200	2,153
	Squeteague................	252,000	9,660	255,850	10,692
	Striped bass................	50,000	4,250	78,000	6,082
	Tautog.....................	25,000	950	52,000	2,070
	Miscellaneous fish*..........	76,500	1,148	118,000	1,580
	Refuse fish†.................	860,000	1,090	1,396,000	1,756
	Total	6,307,100	$143,642	8,293,650	$165,818
Gill nets.............	Bluefish......................	218,500	$16,170	230,700	$13,842
	Butterfish....................	1,000	20	1,800	36
	Squeteague.....	9,000	410	10,650	373
	Total.......	228,500	$16,600	243,150	$14,251
Fyke nets	Flounders...........	93,000	$2,410	125,800	$3,145
Pots..................	Eels....	198,000	12,250	161,000	8,685
Haul seines..........	Alewives...........	1,000	20	2,500	45

* Miscellaneous fish includes the cheaper grades of food-fishes, as flatfish, flounders, scup, squeteague, etc., which have been taken in small quantities and shipped without regard to quantities of different species; also, species of infrequent occurrence not sufficiently important to separate.

† Principally sculpin and menhaden used in the production of oil and fertilizer, and a few other species unfit for market because of their small size or deterioration in quality.

55. *Table showing by apparatus and species the yield, &c.*—Continued.

Apparatus.	Species.	1887.		1888.	
		Pounds.	Value.	Pounds.	Value.
Haul seines..........	Alewives, salted.............	315,000	$6,300	399,400	$8,175
	Alewives, smoked...	50,000	1,000	55,000	898
	Bluefish......................	2,500	250	4,000	400
	Butterfish....................	3,000	60	3,500	70
	Eels..........................	45,000	1,700	45,500	2,457
	Flounders....................	6,000	120	8,000	200
	Perch or cunners...........	61,000	2,440	60,000	2,400
	Sea bass.....................	500	20	600	24
	Shad....	9,200	685	9,000	625
	Smelt.........................	15,000	875	19,300	962
	Squeteague.....	7,000	380	8,500	475
	Striped bass...	11,200	1,074	12,500	1,016
	Tautog.......................	5,000	250	6,250	312
	Total..................	581,400	$15,174	634,050	$18,079
Lines............ ...	Bluefish......................	35,000	$2,100	45,500	$2,958
	Cod...........................	70,500	2,170	73,000	2,245
	Cod, salted..................	15,680	700	14,560	650
	Flounders....................	14,000	810	16,200	400
	Haddock......................	6,500	155	6,000	145
	Mackerel............	225,000	15,000	199,800	16,650
	Mackerel, salted....	176,000	10,560	136,000	10,200
	Pollock.....	50,960	1,752	50,400	1,800
	Sea bass.....................	12,000	430	15,500	504
	Tautog.......................	152,000	6,000	125,250	5,068
	Total..................	757,640	$39,177	682,210	$40,620
	Grand total....	8,115,640	$229,253	10,139,860	$250,543

56. *Table showing the extent of the menhaden industry of Rhode Island.*

Designation..	1887.	1888.
Number of factories in operation	3	3
Value of factories	$193,000	$193,000
Amount of cash capital	$69,000	$70,000
Number of shoresmen employed	177	246
Number of fishermen employed	222	225
Number of steam vessels employed	11	11
Net tonnage	766.88	747.56
Value	$126,000	$135,000
Value of outfit	$30,000	$29,000
Number of sailing vessels employed in fishing	1	1
Net tonnage	27.50	22.44
Value	$1,500	$1,000
Value of outfit	$1,000	$700
Number of sailing vessels employed as "carryaways"	3	5
Net tonnage	42.32	64.08
Value	$1,400	$1,825
Value of outfit	$180	$265
Number of menhaden handled	60,901,670	127,169,670
Value to fishermen	$73,072	$155,004
Number of gallons of oil made	538,623	762,360
Value as sold	$129,539	168,418
Number of tons of scrap produced	3,810	8,551
Value as sold	$81,010	$166,268

BLUE-FISH

came upon our coast the middle of June and remained until the last of October. Their abundance in the waters from Monhegan Island, Me., to the capes of the Delaware has been simply wonderful. Captain Church writes us "that he could have caught more this season with a purse net than he did of menhaden, and of the latter he took about 30,000 barrels. That it made little difference where you went, they were there in large schools." He adds: "Yet some people say they are all caught up. I wish they were, for they are the terror of nearly all other kinds of fish."

BASS.

There has been a marked falling off in the number of these king of fish to the sportsman from last year. Their failure this year has been attributed to different causes, by some to the dumping of garbage near the mouth of the bay. The drift of the lighter portion of this over the fishing ground could hardly be supposed to effect the change, since it is dumped not less than two miles from land and distributed over a large area of surface. The amount of garbage rarely exceeds 150 barrels and probably not over one-third, or fifty barrels, of this floats upon the surface. Of this a small part only ever reaches our shores; some of this is devoured by birds, and we hear of fish being taken with vegetable matter in them; a large pollock was found with a quantity of celery in its stomach. We cannot see that the floating of this small amount of refuse of vegetable matter over the fishing ground can be more deleterious to the fishing than the same quantity of seaweed. That the garbage attracts sharks and the sharks keep off other fish seems more plausible. But the presence of sharks in the water this season in very large numbers is attributed to the unusually warm weather by some of our closest observers, and to this cause we are inclined. While we doubt not the garbage does attract these fish in its locality we hardly think it possible to draw them from distant localities to the extent observed this season.

MACKEREL

have been in or near our coast all the season, but did not take the hook freely; very few were taken except small mackerel, which are reported as very plentiful all along the coast.

[From the Halifax, N. S., Morning Herald.]

LETTER FROM W. H. ROGERS.

COLUMBIA, Pa., June 23, 1891.

The large increase in the catch of mackerel on the Nova Scotia coast this spring is particularly gratifying to the writer, as it doubtless is to the fishermen interested, and particularly so as the failure on the American coast is still more marked than in former years. The reason for this state of things is easily understood by those who have given the subject any thought or intelligent consideration. Scientific investigation both in Europe and America have demonstrated that :

1st. All the mackerel caught by man amounts to but a drop in the bucket to what are destroyed by natural causes and devoured by their natural enemies, both in the sea and upon its surface.

2d. Mackerel are controlled in their movements by temperature and food influences, and not by modes of fishing, sawdust, PURSE SEINES, etc. The matter of temperature is of course beyond the reach of human laws, while that of food supply is not. It is quite obvious to those who will give the subject any intelligent thought that the almost total destruction of the alewive fishery of Nova Scotia up to 1882-3 had well nigh destroyed a very important item in the food supply of the coast fishery in all its branches, as has been the case in other countries. Knowing this I addressed myself to the work of improving fishways and opening the streams for the ascent of anadramous fishes, with what results the public know, and the departmental reports of the catch of alewives during the past seven or eight years prove, and the increasing catch of mackerel bear witness to the correctness of the views I have maintained, and which are recorded in every published report from year to year.

Having done this for my native province in the face of the most fierce and bitter opposition of certain public men who live for nothing but self and have no use for anybody or any improvement unless they contribute to the inflation of their purse or vanity, I am now spending the few remaining years of my life in opening the streams of the United States, and am sending shad, alewives, salmon and other fish over doors and up such rivers as the Hudson, Delaware, Susquehanna, Raritan and other great streams, on some of which scores of thousands of dollars had been wasted on such silly devices as the Hawkins abortion, by men who knew no more of the matter than he does. I note what was said in your columns recently as to the salmon caught in Wilmot's trap at the Rhino dam. I am quite familiar with the conditions existing there, and know what occurred as well as if I had been on the spot, and will assert that no salmon ever did or ever will pass through a Hawkins fishway under a six-foot head or upwards, or alewives under a four-foot head or upwards, and that every dollar spent upon it of either public or private funds will be wasted. The history of a few years will prove the soundness of these views, as it has already done in the sawdust and other important matters in relation to the interests of the fisheries. But then "Experts (?)" are now employed.

W. H. ROGERS.

Tautog

have been plenty on the fishing grounds in the bay, but not so plenty on the ledges outside until late in the season. About the middle of October, when they had gone out of the rivers, they were so plenty that one fisherman caught from 200 to 250 in number in about four hours fishing. This lasted for about three weeks.

Scup

the past season in their approach to our coast came more freely into the Bay. While the outer traps caught much less, those inside caught enough more to swell the shipments beyond that of any previous year of which we have record, excepting that of 1889. They remained in our waters all the season and furnished abundance of fishing. With the schools that came here in May were large numbers of small fish, and they caused the fishermen much trouble to separate them. This was done by large mesh netting that would allow the small ones to pass out.

It was thought that from 1,000 barrels they would save but about 50 barrels of large scup.

It was a great sight to see the millions of these little fellows turned from the traps every morning for near three weeks.

This is reported as the experience of all the traps from Point Judith to Seaconnett.

Surely the presence of these small scup in such immense numbers this year would justify the theory that it will be followed next year by largely increased numbers of the larger ones, and there can be little question of the soundness of this reasoning.

But an unusual depletion of their numbers from natural agencies that are at work, unseen and unknown, while they are absent from us, may, as it often has, disappoint us.

Herring.

These fish that are the earliest comers of all anadromous fishes failed to appear but in very small numbers in our waters, yet they are said to have been very abundant in Buzzard Bay and Vineyard Sound.

THE ANCHOVY

Have been very abundant along the coast; they furnish food for many other fish.

MENHADEN.

The catch has been the poorest for many years, the catch of the whole fleet hardly exceeded the catch of one steamer in 1889. This is owing partly to the restrictive laws in some of the States. The total catch is about 225,000 barrels.

State of Rhode Island, in account with Commissioners of Inland Fisheries:

1891.	DR.	
Jan. 1.	To paid for brook trout eggs, hatching and raising	$84 60
	" Expressage	4 80
May 4.	" Expense on 2,060,000 Shad Fry	24 00
Dec. 31.	" Expenses of Commissioners	44 56
	" Paper, stamps and stationery	8 50
		$166 46

1891.	CR.	
May 16.	By cash from State Treasurer	$65 56
	" Balance due Commissioners	100 90
		$166 46

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
Commissioners of Inland Fisheries.

APR [illegible] 3

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1893.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1893.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1893:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1892.

SHAD.

No shad fry were had this year from the United States Fish Commissioner. The catch in the waters of our state has not been large this year.

TROUT.

Forty thousand (40,000) trout eggs were purchased this year. The fry from these were sent to various parts of the state to persons who applied for them, and deposited in the streams.

Trout fishing has been the poorest the past season of any yet known by the Commissioners, the past two seasons having been very dry and the brooks and streams low. It has been reported to us by reliable persons that trout have been found dead in the pools on the streams where they were left by the falling waters.

We are still of the belief that quicker results are obtained by putting in yearlings than by the method formerly pursued by us of depositing the fry.

TAUTOG

are reported more plenty than ever before known.

It is estimated that twenty tons, 40,000 pounds, were taken with hook and line at Stone Bridge this fall notwithstanding there were nineteen anchored traps set at Seaconnet during the spring fishing, and thirty-three stake traps, within 8 miles of the Stone Bridge during the summer and fall.

Mr. Isaac Cook alone caught 1500 pounds.

We have the statement of Capt. Hunt, that there were 35,000 pounds in cars and smacks in Newport Harbor at one time. The spring fishing in the upper waters of the Bay for tautog and other bottom fish was poor.

BLUE FISH

have been very abundant on the coast, but we think no unusual numbers in the Bay.

SCUP

as will be seen by the tables of shipments have been very abundant, the catch in the traps far ahead of any former year.

BUTTER FISH

are becoming very plenty in our waters and we hear of very large schools of them outside the Bay.

MACKEREL

have been about in considerable quantities, mostly of the small size, but not a large number taken.

They are said to destroy very much of the spawn of lobsters.

STRIPED BASS

have been scarce this season. It is to be hoped that this much valued fish will again become more plenty.

We are indebted to Capt. N. B. Church for the following statement regarding our fisheries. What gives much value to Capt. Church's statements is the fact that he is a close observer, a practical fisherman, and a candid writer. He says:

"The fyke fishery for flat-fish was not a success, the catch being limited and prices were low.

"The catch of herring was also small.

"The catch of scup was the greatest known at Seaconnet.

"Sea Bass were not plenty.

"The river traps did not catch many scup in that vicinity, although they were fairly plenty for the hook and line fishermen all summer.

"Squiteague were very plenty during their season from the middle of June to the middle of July.

"Blue fish were scarce in Rhode Island waters most of the time this season, although they have been abundant on the coast.

"A very light catch of codfish both spring and fall.

"The catch of mackerel was light although there were plenty on the coast."

The following table shows the amount of fish and lobsters shipped by the Old Colony Steamboat and Railroad from Newport for the year ending Dec. 31st, 1892:

Month.	Fish.		Lobsters.	
January	8	Barrels	41	Barrels.
February	16	"	32	"
March	62	"	14	"
April	286	"	127	"
May	17,149	"	276	"
June	6,571	"	253	"
July	1,347	"	659	"
August	216	"	459	"
September	339	"	243	"
October	621	"	4	"
November	167	"	1	"
December	50	"	14	"
Total	26,832	"	2,123	"

From Tiverton Station were shipped as follows:

	Fish.		Lobsters.		Clams.	
January		Barrels		Barrels	17	Barrels.
February		"		"	12	"
March		"	1	"	30	"
April	49	"		"	6	"
May	357	"	20	"	1	"
June	404	"	23	"	4	"
July	417	"	44	"	23	"
August	206	"	43	"	2	"
September	129	"		"	9	"
October	186	"		"		"
November	54	"		"		"
December		"		"		"
Total	1802	"	131	"	104	"

Besides these unusually large shipments, there were shipped by vessels to

New York	about	5,000	Barrels.
Providence	"	5,000	"
Fall River	"	3,000	"
Total	"	13,000	"

Making a total of 41,634 barrels for this season's shipment of fish from Newport county alone.

It is also estimated that 1,500 barrels of fish were lost from the traps by storms.

The following is the amount of fish and lobsters shipped by the Old Colony line for the last ten years from Newport:

1882	12,514	Barrels.
1883	13,874	"
1884	20,301	"
1885	18,421	"
1886	18,439	"
1887	17,491	"
1888	16,194	"
1889	21,353	"

1890	11,583	Barrels.
1891	20,236	"
1892	28,955	"
Total	199,461	"

The following table shows the catch of menhaden for the last seven years:

1886	232,471	Barrels.
1887	175,667	"
1888	377,607	"
1889	508,482	"
1890	560,086	"
1891	225,000	"
1892	51,703	"

THE MENHADEN FISHERY.

The present season has been worse than the last, which was exceptionally a poor season for these fish.

These two past years have proved a serious set back to this important fishery of our state.

The menhaden fishery may be said to have commenced with the invention of the purse net about 45 years ago and has developed into an important industry. In the statistics furnished by the United States Commission we find as follows:

"Rhode Island is now more interested in this branch than any other New England state and the industry ranks among the most prominent enterprises of the state. The capital invested in 1889 was $452,925. 573 persons were employed and 177,133,333 fish were handled, for which $265,700 was paid. The manufactured product consisting of different grades of oil and various kinds of fertilizers were worth $427,757, an increase of $217,208 over 1887 and $93,070 over 1888."

The failure of this fishery the past two years was in part to be attributed to the restrictive legislation of other states.

The menhaden are a wandering ocean fish, and according to the best authority we have, spawn upon the ocean, wander along the coast, from Newfoundland to Florida, sometimes appearing at one place, sometimes at another in large numbers.

To pursue them successfully it becomes necessary to follow them wherever they are to be found.

The antagonism existing in some localities between the practical fishermen, and he who fishes for sport or recreation is unwise, and we believe it often leads to great injustice. We believe in fostering both interests.

The one is an industrial interest that produces much that is necessary to life and affords the means of livelihood to those engaged in it.

The other, a healthy change and relaxation to the merchant, the student, or the professional man seeking relief from over application to their several duties, or anyone else who chooses to avail of it and we believe it right for the State to provide for and preserve this privilege by all fair means, and within reasonable limits, with the same care it would a public park, and very much to the same end.

HIBERNATION.

A boat sunk between Fort Adams and the Torpedo Station about twenty months ago, was raised February 12th and found to contain quite a colony of fish and some small lobsters. The boat had a large quantity of mud in her that had settled so firmly together that it quite stopped the hole made in her, and also the holes in the well, so that both the boat and her well were bailed free of water and the boat floated to the shore at the city dock. The owner thinks that there were half a bushel of cunners and tautog found in her, all in the mud, and we are told that some of them were so embedded in the mud as to leave an imprint of their form.

THE FLUCTUATIONS IN THE NUMBER OF FISH; AND THE NATURAL CAUSES OF THEIR DEPLETION.

The fluctuations from year to year and for indefinite periods have been noted all along throughout the whole history of them.

Often a great diminution without known cause has occured, and also immense numbers appear without any known reason; such has ever been the case with fishes.

These fluctuations were as clearly observed in the middle ages as now, the increase and diminution then caused the rise and fall of towns; their settlement and opulence, as well as their decay and poverty have been due to the increase or diminution of the fishes. In later times the changes have been no less obvious and important.

The influences that produce these changes upon our coast is of especial interest to us.

Unquestionably the great factor in producing the change in numbers is amongst the fishes, the larger or best armed destroying the smaller or weaker.

But those most reduced with us, are those that cast their spawn in the fresh upper water of our streams. Some of these have been so long absent, or their numbers so reduced that we hardly realize that they once existed in great abundance in our waters. Of these the most important are the salmon, shad, herring and bass. While the influence of natural causes is sufficient to produce this change, the generally accepted theory is that the depletion is caused by the obstruction to streams, pollution of the water, and such as arise from the development of the country. We incline to the belief that this is the primary cause of the depletion of the anadromous fishes.

The appearance in ever varying numbers of the fishes that visit our coast every season, affords room for much study, and no end of speculative theory.

Their history while absent is one of the unrevealed mysteries of nature; they are governed by natural laws, that baffle all efforts at investigation.

Still it is a subject of great interest to the student of nautral history, and to the political economist.

The fluctuation in their number is phenomneal, often coming in abundance when few are expected, and few when large numbers are looked for, for instance the appearance of scup in our waters in 1872. Prof. Baird said in 1877: "I was quite satisfied in my own mind that unless something of this kind was done, very serious results would happen. Very much to my disgust I must admit, the next year, even with all the abundance of these engines, the young scup came in quantities so great as to exceed anything the oldest fisherman remembered. Since then scup has been very much more abundant than it was when I wrote my book and report."

Another instance occurred in the menhaden fishery of 1889 (referred to in our report for that year) few being expected but overwhelming numbers appeared, exceeding that of anything known in former years. So it must ever be until we know more of them. Change is the immutable law of their existence.

SOME OF THE DESTRUCTIVE AGENCIES THAT ARE ALWAYS AT WORK TO DECIMATE THEIR NUMBERS.

First of these is the enormous destruction of the spawn by other fish and by storms.

The terrible havoc made by other fish upon the young, and the merciless destruction that continues through all their fish life, by other fish, birds, and animals, and to this may be added their own cannibal propensity that does not stop to discriminate between their own relatives and others; and to these causes may be added diseases, heat, or cold, parasites, convulsions of nature, and the numberless vicissitudes of fish life, known or unknown, observed or not observed by investigators. Sometimes whole colonies are destroyed by unknown causes, as was the case with the tile fish that were discovered by Prof. Baird in such large numbers, and seemed to be annihilated at one stroke.

Having considered the natural causes that affect all fish, and referred to some of the indirect influences of man upon the fresh water spawning fish, we will now enquire into the direct act of man, the capture of ocean fish in large quantities as is now possible by the use of improved methods.

What is the effect upon the fisheries?

Who can answer?

We had thought to leave this question, but inasmuch as our State has especial interest in the solution of this question, as our largest fishing interest is directly and vitally affected by its determination; we feel that we should not be doing our whole duty by evading it, lest we might, like too many others, " step in where angels dare not tread."

We will first see what others have to say about it. The English Commission under Prof. Huxley examined a vast number of witnesses, received answers to nearly 62,000 questions and visited nearly all the fishing localities of Great Britain and Ireland, many of which had been fished over for many centuries, and though in addition to our modes of fishing by weirs, nets and seines, the beam trawl is there used, which is far more destructive to fish and their spawn and young than any mode of fishing by us, that Commission came to the unanimous conclusion that there was no danger to the sea fisheries either in the open sea, or in bays and arms of the sea from over fishing. The points indicated are the following: "That no amount or kind of fishing can diminish the schooling or wandering fishes of the high sea, such as the herring, mackerel and menhaden."

The same conclusions were arrived at in regard to the great herring fishery of the North Sea, in fact, while the investigation was being made (if we remember right) an immense quantity of their spawn became detached from the bottom by a storm, and were driven upon the shore, where it was fed to hogs or carted off for manure, showing that natural causes were at work that were quite sufficient to produce, and did produce great changes, compared to which the catch by man was not to be considered.

The late Prof. Baird estimates the daily destruction of other fish upon our coast at 10,000,000,000 or 2,500,000,000 pounds by blue fish alone and says that their food consists of menhaden, mackerel, herring, scup, and other species.

Does this slaughter go on all the year?

He also gives us an estimate of the number of menhaden devoured on the coast of New England at three thousand million million, 3,000,000,000,000,000, in the summer months.

Does this continue when they are absent from our coast?

He further says "that this calculation might be pursued to any extent but I have presented enough to show that the question of human agencies in the way of affecting or influencing the great ocean fisheries is scarcely worth considering."

Who is there that knows more about this subject?

Whom shall we consult?

If no better is offered we shall still quote from him: "If it were in any way our duty to take measures for the prevention of the destruction of life in the sea, and of maintaining the yield of fish generally at its largest figure, we could accomplish it in no better way than by increasing the extent and magnitude of certain of our fisheries.

"Thus I have shown that there may be a saving of herring by the capture of the cod and ling on the British coast. For every bluefish captured in the waters of the United States many hundreds of other fish are left to enjoy their life, perhaps however, in their turn to be the means of an increased destructiveness in another series of animals.

"The capture of whales gives a respite to the schools of mackerel and menhaden, while the destruction of the herring and menhaden relieves though in an infinitesimal degree, the drain upon the crustaceans and the smaller fish."

We repeat the question. What is the effect of the taking of fish in quantities now possible by human methods?

We have in the foregoing presented the conclusions of three different commissions composed of eminent scientists, who made as thorough investigations as it were possible, and all agree in their conclusions.

We were sure from past experience, there are hundreds ready to "step in" and say there can be no question about it. But we will ask them to pause while we consider the question further, and ask them the questions that we think have an important bearing upon the question before us. The depletion of fish in our waters are chiefly salmon, shad, herring and bass, and as these are all fresh water spawners and some of them left our waters long before the adoption of modern appliances, and none of them have been taken in large quantities by them. This fact may have some significance as to these fish; but we are not now considering them at all.

We propose to apply all we have to say here to the ocean fishes, those taken by methods considered most destructive with us.

These are the scup, menhaden, and the bluefish, two of these we know to have been rare in our waters, the scup in 1794 and the bluefish in 1822.

What caused the depletion of the scup in the last century? Or the bluefish in the early part of this century?

In 1870 it was thought that scup were being exterminated since which there has been an uninterrupted fishing for them by improved and continually increased numbers of traps and the catch of the last year far exceeds any former year. How is this possible were they being decimated?

How were it possible to take such exceeding large numbers of menhaden in 1889 and 1890 if their numbers had been so decimated by previous years fishing?

Will some one wise in such matters tell us where these fish are when absent from our waters?

How old they get to be?

Are they subject to vicissitudes when absent?

What nature?

What becomes of all the old fish?

With such immense numbers the natural mortality must be very large. Why do we not see some trace of them?

Do predateous fish live on others when absent from us?

Do menhaden live on the spawn of other fish?

Do mackerel devour the spawn of lobsters?

Do menhaden?

If so, what effect does it have upon the stock in the waters?

Do small fish or crustaceans affect the number of large ones by destroying their spawn?

If bluefish destroy menhaden, mackerel, herring and scup, may not these fish compensate by devouring the spawn or young of the bluefish, and in that way retaliate upon their enemies?

If anyone can answer these questions, them would we vote wise enough to have a hand in the government of the fishes.

God alone rules the universe and to his infinite wisdom we must leave this, until we have learned at least something more than we yet know, then it will be quite time to try to assist Him in the government of the fishes of the sea.

We think that there will be found here some difficulty in governing the fisheries suggested; just which to foster, and protect, and which to destroy in order to preserve the most desirable and have a favorable result.

Who is there wise enough to know how to do this?

Who is there that can say that any plan to govern is more than an experiment and if apparent success comes he is by no means sure it is through any means he has applied?

HIGH PRICES DO NOT INDICATE SCARCITY OF FISH.

Prof. Baird in report for 1886, page 23:

" One supposed evidence of our increasing scarcity of fish is the increase in price at such stations. This is, however, a fallacious argument, as the market is regulated by the rates obtainable in the centers of supply rather than elsewhere, and the local prices necessarily must correspond."

This does not entirely account for the advance in prices over former years, when there was no such thing as a fish market and the fisherman sold direct to the consumer from his boat landing, or from a wheelbarrow at the street corner.

Now all is changed; the fisherman ships direct to the wholesale dealer, or to the retailer, who have large markets and heavy rents, quantities of ice, and help to clean, and teams to deliver, besides long book accounts, and losses. The retailer fixes his prices and makes his margin to cover all these contingencies, and most of the fluctuations of the wholesale market, and maintains a quiet, uniform price not much affected by the degree of plenty or scarcity of fish.

The second convention of the Fish Commissioners of the New England states occurred in Boston, November 16th, 1892. These meetings offered the means of interchange of views of representatives of the different states that cannot fail to be of profit to all.

The subjects discussed chiefly, were relating to the protection of fish and game.

A proposition was favored limiting the size that a lobster could be taken to 10½ inches. We believe that a uniform rule is generally desired by the fishermen and to some extent it may help the fisheries.

But we feel sure that in order to be effective it should include those states that furnish a market for the great bulk of the product.

The lobster business has grown to be of much importance, they furnish a delicious and healthy food, and the taking of them is the means of livelihood of a large class.

Experiments are being made to propagate them, and it is with deep interest we watch for favorable development in this line.

We trust that some day we may do something in the way of increasing their numbers in the waters of this state.

The Fish Commissioner of Newfoundland has under his direction hatched and planted in 1892, 426,285,000 lobsters.

NOTE—For the above we are indebted to Dr. H. R. Storer, who has manifested much interest in this subject, and received the above item from his correspondent. He also assures us that much faith is expressed in the enterprise. Lest he may appear erratic the representative from this state at the conference of Commissioners at Boston, will say that the report as published of said meeting credits him with the words of another, and he is thus made to appear on both sides of the question of the proposed trout law, when in fact he expressed very decided views upon one side only, that was, disapproval on general principles whether it applied to chickens, or trout, or any product not wrong in itself.

State of Rhode Island in account with Commissioners of Inland Fisheries:

1891.	DR.	
Dec. 31.	To balance due Commissioners	$100 90
1892.		
Mar. 14.	" paid for brook trout eggs, hatching and raising	75 00
Dec. 12.	" " printing, stamps and stationery	28 65
Dec. 31.	" " expenses of Commissioners	10 13
		$214 68
1892.	CR.	
Apr. 11.	By cash from State Treasurer	$160 90
Dec. 31.	" balance due Commissioners	53 78
		$214 68

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,

Commissioners of Inland Fisheries.

29 150

State of Rhode Island and Providence Plantations.

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ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1894.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1894.

[illegible]

State of Rhode Island and Providence Plantations.

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JANUARY SESSION, 1894.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1894.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1894:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1893.

BLACK BASS.

This valuable food fish continues to increase in the waters of our State where introduced, and many large catches have been reported to us.

TROUT.

Seven thousand (7,000) yearling trout were purchased and apportioned out to applicants for them, to be placed in various waters of the State.

The Commissioners have had but few reports of any considerable catches the past season, and, from general reports, consider it the poorest season yet. This is the third consecutive season of low streams during the summer and fall months.

TAUTOG.

We have a few reports from line fishermen of large catches in the upper waters of the bay during the spring fishing, but many of good catches in the fall were reported.

SCUP.

No large catches of scup by line fishermen have been reported to us, although large quantities have been reported as caught in the traps at the entrance to the bay. The catch a little below last season.

BLUE FISH.

Only a few have been taken this season by line in upper waters of the bay, and have been scarce in the waters of this State the last season; indeed very few were to be seen except at Block Island, where they had a fair catch, and we understand that there was good fishing for them along the coast west and south of us.

SQUITEAGUE.

This fish was taken quite plentifully off Warwick Light, north end of Prudence and at Hope Island by parties fishing for them expressly; some parties fishing for bottom fish report their taking that bait.

BUTTER FISH

still remain with us in good numbers. These are taken entirely by traps.

MACKEREL

have been quite abundant, but most of them of small size. The bullseye variety has been quite plenty.

STRIPED BASS

have been scarce, and as this is the most valued of all game fish, it is much to be regretted.

SEALS.

The presence of seals in the bay last season was remarkable, we have never known so many to be observed in our waters in one season.

Captain Chandler tells me that he counted 23 in sight at one time, and others have noted their presence in large numbers. These hair seals are great fishermen, and it takes quite a number to make a meal for them; what would be required to satisfy them it would be difficult to calculate.

Account of fish and lobsters shipped in 1893, from Newport, R. I., by Old Colony Steamboat Co.:

Month.	Fish.		Lobsters.	
January	5	Barrels	3	Barrels.
February	26	"		
March	82	"		
April	60	"	6	"
May	7,844	"	197	"
June	8,840	"	305	"
July	3,435	"	356	"
August	1,622	"	296	"
September	861	"	170	"
October	1,102	"	39	"
November	449	"	6	"
December	126	"	21	"
Total	24,452		1,399	

The following is the amount of fish and lobsters shipped over the Old Colony line for twelve years, from Newport:

1882	12,514	Barrels.
1883	13,874	"
1884	20,301	"
1885	18,421	"
1886	18,439	"
1887	17,491	"
1888	16,194	"
1889	21,353	"
1890	11,583	"
1891	20,236	"
1892	28,955	"
1893	25,851	"

LOBSTERS.

The undersigned would respectfully report that under the Act of Jan., 1893, he has the last year secured the eggs from 295 lobsters, which were set free in the waters of the State when hatched.

Thus has he caused to be returned to the water four million of young life that cannot fail to have some effect upon the numbers in the waters, if but a small per cent. of them reach maturity.

It is hoped that some plan may be devised whereby all the eggs from all the lobsters taken in this State may be secured and returned to the waters after hatching.

J. M. K. SOUTHWICK,
Chairman Fish Com.

THE CONVENTION AT NEW YORK.

The most notable event of the past year relating to the fisheries was the conference held in New York City, Dec. 13th and 14th.

It was composed of Fish Commissioners from all the Northern Atlantic States, and others interested in the coast fisheries.

This State was represented by J. M. K. Southwick and Mr. George N. Bliss on the part of the Fish Commissioners, and by Daniel T. Church, James Church, William A. Brightman, and John Lewis as interested in the fisheries.

The call to this conference assumed that there was a growing scarcity of edible fish all along the coast.

That the cause was the use of nets.

The remedy the restriction of nets.

This left nothing for the convention to do but agree upon uniform restrictive laws as suggested in the call.

As it was proposed to question the assumed fact, that fish were diminished, the meeting was conducted in a free and impartial manner.

In behalf of those who called the conference it was shown that with hook and line fish could not be taken in as large number as formerly on the fishing grounds.

This, it was claimed, was evidence of a general diminution of sea fishes.

On the other hand it was shown by statistics of fisheries, of transportation companies, and of the markets, that a very large increase of edible fish found their way to the markets from traps.

This is claimed as proof that no diminution has occurred.

If it is admitted that both sides proved their case, and we believe they did, so far as relates to the catch of fish in the different ways indicated, the conclusion is inevitable that the failure is local, not general, and must apply to specific fish, not to the ocean fishes generally.

The wandering ocean fishes like the squiteague, the blue fish, the menhaden and the mackerel are too capricious in their movements to count upon their presence anywhere with any degree of certainty. To attribute their absence in a locality to a scarcity in the ocean is a fallacy that was clearly demonstrated the past season, in the failure of weak fish in Barnegat Bay, while on the Jersey coast they were very plenty, and on the south coast of New England they were more abundant than ever before known.

To give satisfactory reasons why the hook and line men, who stated their experience, found less fish than formerly is perhaps beyond the power of man; still there are causes at work that doubtless affect more or less the anadromous fishes that visit us, and seek pure water in upper streams to deposit their spawn, but who, if they succeed in overcoming obstructions in the rivers, find the waters poisoned by sewerage, chemicals, and other deleterious substances destructive to the young fish life. These impurities are carried down stream by tides and deposit over the bottom, and to this is added the mud from dredging that is dumped in the channels and lodges in the eddies, covering vegetable and animal life that would attract fish. Then there are changes effected by natural causes, storms sometimes scour the bottom of vegetable life, or cover it with sand or mud.

At times the fish will not take the hook from some cause, it may be because gorged by the abundance of normal food, they will not be tempted to take the hook, let it be baited ever so well.

The result of this meeting was the bringing face to face of the parties representing both sides of the question. It can but have the effect to broaden the views of each, and lead to a more thorough study, and we trust, a better understanding, of the subject of our own fisheries.

The following observations of the fisheries, during the past year, are from the pen of Capt. E. B. Church:

"The menhaden began to show on the coast early in May this season and gave promise of being abundant; they went into Long Island Sound in the usual quantity, and into Narragansett Bay in rather more than the usual quantity; they remained in the bays until about the last of July, when they left and did not return. The early reports from Maine were very encouraging, the pound fishermen reported catching of more than ever before early in the season. But the steamers that cruised the coast failed to find any.

It is the general belief that there was a body of menhaden on the coast, but did not show up at the surface, this belief was strengthened by the appearance of a large body of these fish in Provincetown bay late in October. A large body of menhaden remained in Buzzard's Bay all summer.

The fishermen found a large body of menhaden on the outside of Long Island early in October; where they came from no one knew, they followed them down the coast as far as Brigantine shoals where most of them disappeared; some few were caught south of there, in the vicinity of the Delaware, but not many. This body of fish did much towards bringing this year's catch up, although it is still much below the average. Both in the Delaware and Chesapeake menhaden were plenty, and good catches were made, but, on the whole, business has been unprofitable, owing to the small quantity of oil in the fish."

"Scup and sea bass were abundant on the coast during their migration, more so than for many years, but there were very few caught during the summer in the rivers and bays."

"Squiteague were very plentiful, so much so that they were hardly worth catching in traps. It is safe to say the loss of these fish from the pounds in East River was from 200 to 400 tons during the August storm."

"Blue fish were first taken this season the last of March or early in April, in the vicinity of Cape Hatteras, where a large fleet of New York smacks go to make early catches. I think there is about sixty fitted from the Fulton Market alone. They found a good body of fish, but they did not take the hook freely when first found; they came up the coast slowly, in fact, the great body of them remained south of Barnegat all summer. A fairly good school came on our coast in July, but went to the east; good catches were made in Vineyard Haven, and they are also reported in considerable numbers off Newburyport. There have not been such large numbers seen along the coast this year as there were for the last three previous years.

"There was one noticeable thing about them this year, most of them were very large.

"If I dared guess on the subject, it would be that there would be less of them in 1894. Notwithstanding their young were very abundant in the waters this fall."

State of Rhode Island in account with Commissioners of Inland Fisheries:

1892.	Dr.	
Dec. 31.	To balance due Commissioners	$53 78
1893.		
Oct. 23.	" paid for yearling trout	230 00
	" " express on trout and advertising	18 20
Dec. 8.	" " printing, stamps and stationery	7 25
Dec. 31.	" " expenses of Commissioners	50 35
		$359 58

1893.	Cr.	
Mar. 24.	By cash from State Treasurer..........................	$53 78
Oct. 25.	" " " " "	206 85
Dec. 31.	" balance due Commissioners.......................	98 95
		$359 58

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,

Commissioners of Inland Fisheries.

29150

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

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MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1895.

PROVIDENCE:
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1895.

[illegible]

State of Rhode Island and Providence Plantations.

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AT ITS

JANUARY SESSION, 1895.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1895.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1895:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1894.

TROUT.

The Commissioners have purchased ten thousand (10,000) yearling trout, most of which have been distributed in the various waters of the State. A few hundred will be retained for distribution early in the spring.

The trout fishing, the past, as for several seasons, has generally been poor, though some good catches are reported. This, in part, is due to the very low state of the water in the streams, which in some cases have dried to their bottom and thereby destroying the fish, in part undoing what the Commissioners are trying to do, by restocking. We could do more and to better advantage if our appropriations were larger.

BLACK BASS.

The Commissioners have been enabled through the good offices of Fred Mather to obtain a limited number of adult, large mouth Black Bass, it being deemed desirable to introduce them into some of our rivers which are now practically without good food fishes.

The small mouthed Black Bass are very plentiful in the ponds and streams where they were placed by our predecessors and are valued more highly each year as a food fish.

SHAD.

Through the kindness of U. S. Commissioner M. McDonald there were placed in the head waters of Palmer River at Shad Factory about two millions (2,000,000) Shad Fry. As has been before stated by us, this is the only body of water unobstructed by dams in our State. We have also applied for an apportionment of eggs of the Land Locked Salmon.

BAY FISHING.

The fishing in the upper portions of the bay for Tautog and Scup has been very poor, but Squiteague have been taken very freely by hook and line. The season has been unfavorable to the net fishing during the spring; while some few did very well, most of them got but poor returns for their outlay and efforts. In the lower portions of the bay, as the season advanced, the Squiteague and Menhaden became very plenty and the season's catches of these fish were large. The Tautog or Black fish were quite plenty all the season.

Blue-fish were plenty at Block Island, but not many in the bay.

Bass showed an increase of numbers over former years.

We are pleased to give in full the following letter from Capt. N. B. Church. It gives a very clear idea of the menhaden fishery as well as his observation of other fish along the coast.

NEW YORK, December 22, 1894.

J. M. K. SOUTHWICK, ESQ.

Dear Sir: Your letter of the 19th is at hand and I am very sorry to say that I am not prepared to give you a very full report of the general fisheries. I will not attempt to write about our local spring fishing as you are probably more familiar with it than I am. The Menhaden fishery for the whole coast has been a fairly prosperous business.

Some of the Chesapeake fishermen started out in March with the idea of going South to find them in their Southern quarters, but they had not gone far south of Cape Hatteras when they found them very abundant; they fished on them and followed them into Chesapeake Bay, where they had very good fishing for a short time. They were next seen on the Jersey coast, and in and around Sandy Hook Bay where they had good fishing for a while, then the fish turned and went into Chesapeake Bay where they had very heavy fishing all summer. This body of fish was small in size and very poor in yield of oil. The body that locates on our coast struck in in May, great bodies of them located in Long Island Sound and in Narragansett and Buzzard's Bay, and also in Boston Bay, and the bays and rivers of Maine. No great catches were made in Maine or Boston Bay owing to the fish being on the rocks and in strong tides in the latter place and on account of their not showing but a short time each day in Maine.

Good catches were made in our bays and rivers until they went out of them early in August, as they usually do. The very blowy weather in October and November was fatal to the fall fishing, which would have been good under more favorable conditions of weather, as there were large bodies of fish seen all along the coast.

Some of the Southern boats followed the Menhaden south of Hatteras, and they told me that the bodies were so full of live sharks when they got there that it was impossible to catch them, they would bite the seine so badly.

Blue fish have been very abundant south of Montauk all of the season, so much so that half of the fishing smacks engaged in catching them, hauled up early in the season. Squiteague have also been abundant as have been about all of the local varieties of our coast, such as Summer Scup, Tautog and other varieties. Striped Bass have been caught in larger quantities this summer than for several years.

The Whiting catch is a wonder; they have been so abundant in Provincetown Bay as to spoil the fishing for other varieties, the pounds being full of them nearly all the time. I am sorry I cannot go into the matter of local fishing more thoroughly, but I have been home so little this summer that I have had a very poor idea of it.

Thanking you for your kind expressions,

I am, &c.,

N. B. Church.

Account of Fish shipped from Newport, R. I., by Old Colony Steamboat Co., in 1894.

Month.	Lobsters.	Fresh Fish.	Salt Fish.
January	43 barrels.	68 barrels.	barrels.
February	14 “	83 “	
March	12 “	142 “	
April	69 “	178 “	
May	192 “	7,509 “	
June	270 “	6,089 “	
July	844 “	1,240 “	
August	476 “	184 “	
September	392 “	587 “	
October	31 “	1,040 “	
November	14 “	363 “	24 “
December	35 “	286 “	68 “
Total	2,392	17,769	92

Total for 1893. Lobsters, 1,399 barrels. Fish, 24,452 barrels.

Estimate of salt water fishes caught in Rhode Island waters from shore, west of Point Judith.

Porgies	2,315 barrels.
Sea Bass	232 “
Flounders	516 “
Flat Fish	216 “
Blue Fish	259 “
Weak Fish	53 “
Eels	172 “
Smelts	187 “
Herring	1,500 “
Black	60 “
Mackerel	40 “

Striped Bass	12	barrels.
Shad	8	"
Squid	2,060	"
Menhaden	30,000	"
Lobsters	20,615	"

LOBSTERS.

The Chairman of the Commission would here report that in the past year he has devoted much time and study to the propagation of Lobsters.

As much of the work was necessarily experimental he has therefore given more attention to learning the best methods than to the production of large apparent results. He has made some important experiments that will be of value in the future. While the hatching of eggs in incubators has been attended with a fair degree of success he is of the opinion that any way differing from that of nature must be with greatly increased waste, both before and after hatching.

He would, therefore, approve of retaining the egg lobsters until hatched, and then either return them to the water, or exchange them for other egg lobsters. Without a large outlay this must be about all that can be accomplished.

But the subject is one of great interest and requires the most patient and thorough study before determining all the points to be considered. In the successful propagation of the lobster, the most important of all seems to us to be the rearing of them to an age when they shall have passed the first and most precarious stage of their existence. Should the State ever see fit to acquire control of some arm of the sea, then it may be made possible to retain the young lobsters until sufficiently developed to sink to the bottom and escape the most hazardous period of their lives, thereby much increasing the chances of ultimate maturity.

The complaint has been very general from fishermen and those not fishermen that the law relating to the size of lobsters that may be taken, has been continually violated ; to the detriment of the honest fishermen and the lobsters are not allowed to mature.

We recommend that some one be designated to enforce this law in the different towns where it is violated.

In the study of our fisheries it has often been suggested that the mud dredged from our harbors and rivers and dropped in the channels, was carried to all parts of the bay and in fishing grounds outside and deposited in quantity sufficient to be seriously detrimental to the fisheries. In this way some of the changes that have been noted and complained of have been explained.

In order to get some reliable data on this subject we applied to Capt. W. H. Bixby, who has charge of the U. S. Engineer's Department and he very kindly gave us the following table, giving the desired information relating to the work by the general government.

TABLE SHOWING THE AMOUNTS OF MATERIAL—MUD, GRAVEL, SAND, CLAY, BOULDERS AND ROCK—REMOVED FROM NARRAGANSETT BAY AND ITS TRIBUTARIES FROM 1867 TO 1894, IN CUBIC YARDS.

YEAR.	Pawtucket River.	Providence River, Green Jacket Shoal.	Providence River.	Taunton River.	Mt. Hope Bay.	Newport Harbor.	Potowomut River.	Wickford Harbor.	Yearly Totals.
1867............	12,430	....	42,219	....	....	....	....	....	54,649
1868............	....	....	....	....	....	....	....	....	....
1869............	878	....	....	....	....	....	....	....	878
1870............	....	....	18,201	....	....	....	....	....	18,201
1871............	16,257	....	27	....	....	....	....	....	16,284
1872............	....	....	....	....	....	....	....	....	....
1873............	26,073	....	....	....	....	....	....	....	26,073
1874............	....	....	30,529	3,668	....	11,530	....	11,218	56,940
1875............	7,248	....	....	8,244	634	43,303	....	13,574	73,003
1876............	31,347	....	....	4,145	21,859	58,928	....	6,336	122,115
1877............	....	....	....	93	....	....	....	....	93
1878............	....	....	....	....	12,994	....	....	....	12,994
1879............	....	....	72,314	233	....	....	....	....	72,547
1880............	....	....	327,559	190	....	....	....	....	327,749
1881............	....	....	484,125	12,190	....	....	....	....	496,315
1882............	....	....	391,295	23,232	....	206,800	15,012	....	636,339
1883............	....	....	502,304	33,723	....	130,395	....	....	666,421
1884............	....	....	217,724	27,806	....	....	....	....	245,530
1885............	....	....	625,073	7,658	....	62,673	....	....	695,404
1886............	212,734	....	....	....	....	20,185	....	....	232,919
1887............	31,069	....	111,372	11,450	....	56,353	....	....	210,243
1888............	72,249	206,431	199,580	4,382	....	60	....	....	482,702
1889............	....	....	....	....	....	....	....	....	....
1890............	55,051	147,520	96,034	....	....	39,661	....	....	388,206
1891............	....	....	140,673	1,020	....	34,846	....	....	176,359
1892............	72,213	125,104	87,776	2,650	....	....	....	....	287,743
1893............	....	....	75,489	5,224	....	....	....	....	80,713
1894............	32,975	65,272	351,963	....	....	150,740	....	....	600,950
Totals........	570,524	544,327	3,774,257	145,906	34,987	815,414	15,012	31,123	5,931,550

This shows the total amount removed as 5,931,550 cubic yards; besides this is a larger amount done by cities and by private parties. That it has some effect seems certain when we consider that two square miles, one yard deep or seventy-two (72) square miles, one inch deep is thus dumped in our bay and carried about by the tides; the extent of the effect none can tell, but it is doubtless one of the ways that man has for disturbing what has been erroneously called "balance of nature."

This term has been much used and as applied to the fisheries, we consider a snare and a delusion. As used, it implies that nature has established and would maintain a certain equilibrium in regard to animal life in the ocean, but for the acts of man; that man bears no part in the economy of nature, his acts are therefore unnatural, artificial and that he alone is a disturbing force.

Now we believe with Sam Slick, that man has a good deal of nature about him, and that he should be weighed and reckoned with other forces of nature. That his is the most potent, none can for a moment believe. Exactly what his relation is to other forces as a destructive agent we cannot say, but upon that one point depends the issue of the controversy over our fisheries.

We must deny that God or nature has any such laws as implied in the phrase "balance of nature." Nature has no balance as implied. When she goes on the rampage she upsets things generally and does not stay, because to go farther would disturb the 'balance.' She has various ways of marshalling her forces and undoes her own or man's work of centuries in a minute.

The whale, the shark, the seal, the blue-fish cannot be counted out of the category of nature's forces. Does any one know of any retaining power that stays their hungry and destructive jaws when their prey is reduced to the limit of this "balance of nature?" Does any convulsion of nature or any of its forces stop before upsetting the "balance?"

We cited the work of man in our bay in twenty-five (25) years;

the natural forces of a freshet would do more in as many hours in some rivers, but whether done by man or by natural causes the result of a change in the bottom is destructive of small animal and vegetable life and must be deleterious to the fishes.

J. M. K. SOUTHWICK,
Chairman.

State of Rhode Island in account with Commissioners of Inland Fisheries:

1893.	Dr.	
Dec. 31.	To balance due Commissioners	$98 95
1894.		
Dec. 31.	" paid for yearling trout	500 00
	" expenses of Commissioners	114 63
	" " transportation cans	18 00
		$731 58
1894.	Cr.	
Feb. 27.	By cash of State Treasurer	$98 95
Dec. 31.	" balance due Commissioners	632 63
		$731 58

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
CHARLES W. WILLARD,
ADELBERT D. ROBERTS,
Commissioners of Inland Fisheries.

29,150

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1896.

PROVIDENCE, R. I.
E. L. FREEMAN & SONS, PRINTERS TO THE STATE.
1896.

[illegible]

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

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1896.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1896:

The Commissioners of Inland Fisheries herewith present their report for the year 1895.

TROUT.

Ten thousand (10,000) yearling trout were purchased by the Commissioners, and have been placed in the streams and ponds of the State. More applications for trout fry have been made the past season than for many years, showing an increasing interest as well as a kindly disposition to aid the Commissioners in their work.

Reports from the fishermen the past season show better catches than last year, the water in the streams having been higher.

VON BEHR OR BROWN TROUT.

Through the kindness of the United States Commission we expect to receive in February, 1896, ten thousand (10,000) eggs of this species, which will be hatched, reared until fall, and then distributed in the streams and ponds of the State. This is a very rapid growing fish.

BLACK BASS.

The fishing for this valuable food and game fish the past season has been better than for a number of years. Notably in Watchaug Lake, Moswansicut and Wallum and other ponds, where large catches have been reported throughout the season. Watchaug

Lake has its outlet into the Pawcatuck river, and through this connection this river can now be said to be fairly well stocked with the small-mouthed black bass. It being conceded that the large-mouthed species will thrive even better than the small-mouth in rivers of this character, it is the intention of the Commissioners as soon as practicable, to introduce the former fishes into the larger rivers and many of the ponds of the State.

BAY FISHING.

In the upper waters of the bay the fishing has been very good during the past season. Squiteague, hickory shad, scup and small blue fish were very plentiful from the first of July to October.

The tautog fishing, spring and fall, has been only fair. Small scup appeared in the upper portions of the bay early in July, weighing about twelve or sixteen to the pound, and, as was often reported to us, the river bottom seemed to be paved with them. Later in the season they were taken weighing from one-half to three-quarters of a pound each. Fishing was good from Hope Island to Fox Point.

Squiteague were taken weighing from one and one-half to eleven pounds. At Pawtuxet, in October, squiteague from four to six inches in length were taken very plentifully along the wharves.

The fishing in the lower portions of the bay the past season has been in some respects unique; there has been on the whole a very good season, at times very abundant, then of a sudden would they be gone. This frequent change has been quite a remarkable feature of the last season; the fish were not equally distributed; while some caught very largely, others did not catch the usual amount.

The scup were here in good numbers.

The squiteague were extremely plenty.

Black fish were plenty, the fall catch exceeded any before known.

The bass, the most highly prized of all our game fish, were not very plenty; from some cause they do not regain their former abundance. We believe that to be due in great measure to the want of access to pure water at the head waters of streams, a trouble that besets all our fresh water spawners.

Account of Fish and Lobsters shipped from Newport by the Old Colony Steamboat Line, during the year 1895:

MONTH.	FISH.	LOBSTERS.
January	74 barrels.	20 barrels.
February	91 "	1 "
March	70 "	1 "
April	186 "	41 "
May	11,794 "	275 "
June	6,291 "	407 "
July	8,544 "	833 "
August	1,015 "	281 "
September	644 "	170 "
October	544 "	37 "
November	179 "	13 "
December	190 "	40 "
Total	24,622 "	2,119 "

Approximate estimate of the amount of fish taken from waters west of Point Judith:

	BARRELS.
Porgies	8,700
Sea Bass	800
Flounders	400
Blue Fish	825
Smelts	225
Herring	1,500
Black Fish	90
Striped Bass	10
Menhaden	15,000
Lobsters	150

The fishing for porgies is reported as somewhat better than in 1894, but the catch of lobsters has fallen short of past seasons.

The following table shows the amount of Fish and Lobsters shipped over the Old Colony Steamboat and Railroad for the last ten years:

YEAR.	FISH.		LOBSTERS.		TOTAL.
1886	——	barrels.	——	barrels.	17,434
1887	16,657	"	834	"	17,491
1888	15,033	"	1,161	"	16,194
1889	19,306	"	2,047	"	21,353
1890	8,933	"	2,650	"	11,583
1891	18,082	"	2,204	"	20,286
1892	26,832	"	2,123	"	28,955
1893	24,452	"	1,399	"	25,851
1894	17,769	"	2,392	"	21,161
1895	24,622	"	2,119	"	26,741
Total	171,636	"	16,929	"	206,999

MENHADEN.

For an account of these fish we submit the following from Capt. N. B. Church, who has so often kindly furnished us information:

NEW YORK, Dec. 31, 1895.

JAMES M. K. SOUTHWICK, ESQ., Newport, R. I.

MY DEAR SIR: Replying to your favor of Dec. 27th, regarding the menhaden fishery, would say that the catch taken as a whole has been a fair average with the last five years. The fish appeared in Chesapeake Bay later than common owing to very cold weather in that vicinity, and when they did come late in April did not show on the surface so that they could be caught, until about the first of July, when they were caught in large quantities from that time until the close of the season. From the Chespeake Bay up to and including the Delaware Bay the fishing has been good all of the season, in fact it has been the best on record at the latter place, both in catch of fish and yield of oil. Sandy Hook Bay and tributaries has had plenty of menhaden this year, as has also Fire Island Bay, and the fishermen in these places have had a good season.

You will please notice that these fish have been in the bays, probably owing to the large bodies of blue fish on the coast. In Long Island Sound and vicinity fish have been scarce, no large catches having been made for the season. Rhode Island fishermen have not had good fishing in their waters, except for a few weeks early in the season when they were fairly plentiful in all the bays and rivers.

There has been a large body of menhaden in Buzzard's Bay all summer.

Few fish have been seen in Cape Cod Bay or Boston Bay this season, but the season in Maine opened in July with very flattering prospects. For a few weeks the fish showed well and the fishermen had all they could do to care for their catch, but after the month of July they sank just below the surface of the waters so they could not be caught. Occasionally they would come to the surface for a few hours. I can give you totals on catch of fish and make of oil later if you want them.

All kinds of food fish have been abundant all along our coast.

Yours, etc.,

N. B. CHURCH.

NEW YORK, January 20th, 1896.

J. M. K. SOUTHWICK, ESQ., Newport, R. I.

DEAR SIR: The following is a report of the menhaden industry for 1895:

Factories in operation	42
" not in operation	5
Men employed ashore	1,064
" " afloat	1,212
Sailing vessels in use	35
Steamers "	48
Pounds in operation	24
Fish caught	461,747,850
Gallons oil made	1,767,754
Tons crude scrap made	21,965
" dry " "	18,682
Capital invested	$1,543,000

As you desire the result of the Rhode Island fishing, I give you that separately, but it is also included in the above table.

Yours truly,

N. B. CHURCH.

Result of Rhode Island menhaden fishing:

Factories in operation	8
" not in operation	0
Men employed ashore	140

Men employed afloat	164
Sailing vessels in use	1
Steamers "	8
Pounds in operation	5
Fish caught	39,483,600
Gallons oil made	344,845
Tons crude scrap made	3,637
" dry " "	0
Capital invested	$520,000

REPORT OF CHAIRMAN OF COMMISSION ON LOBSTERS.

The constant and increasing demand for lobsters, and the greatly increased efforts to supply the demand have caused much serious inquiry as to their ability of maintaining the stock in the waters.

Although they occupy all the ground of our coast generally fished over, they are subject to so many perils that it sometimes seems a miracle that any survive.

PERILS.

Perils are ever present with them. At no period of their lives are they safe from natural enemies; the codfish, haddock and the black fish prey upon them in every condition of their existence, large or small, hard or soft shell, but their greatest danger is during the moulting period, when they become the most helpless creatures in the world, and are eagerly devoured by all sorts of fish life; and their own cannibalistic propensities justify the belief that they materially aid in the destruction of their own kind regardless of consanguinity. In this the lobsters have no better record than other fishes, and our experience with the young shows them not a whit behind the worst characters among fishes.

The first peril that besets the lobster begins with the eggs; when attached to the mother they are often stolen by some small predatory fish or eels; the latter is said to be the most guilty party in this, the first menace to their increase. As the eggs hatch, the little fellows rise to the surface and remain free swimmers for several weeks, and during this period they are gobbled up by the million by mackerel and other fish who seem to consider them their normal food. We have seen small schools of mackerel and also butter-fish after them as soon as liberated, and swallow them as a hungry fowl would grain; that made us think, "that since they were so soon done for, that must be what they were begun for."

What escape *this* danger find new ones every time they go to the bottom to moult, which in their early life occur every few days. The period extends as they advance in life. After development to a certain stage they go to bottom and take the chances of life with their progenitors. While they have at this time passed through the most hazardous period of their lives, and have greatly improved chances of reaching maturity, they are still in great danger, and will lose very many of their number before reaching the legal size of ten inches.

As it is a law of nature that animal life must be sustained by nutriment, it appears that the excessive product of eggs and young among fishes is one, if not the chief provision of nature to supply such nutriment. Were it not so none could long exist, and the ocean would be too small for any one of the prolific breeders.

We would not have it understood that the spawn or young of lobsters or other fish is the normal food of their kind. But like the young lobster in confinement without other food, thousands would have but one representative in time. That such destruction would take place under favorable natural conditions where they could spread over a large area, and have a supply of normal food, none can believe. If such conditions could be produced and such food could be supplied as they find in their native waters, then would we have the secret for rearing them, that has so far been found impractical.

The writer has been informed by Prof. A. Agassiz, that he has retained the young lobsters during the season, to what extent I do not know, but to have kept them at all is accomplishing more than anyone else, so far as we know.

This we trust will point to a successful solution of the artificial propagation of this valuable crustacea at no very distant day.

The effect of human agency in depleting the lobsters by the capture of half-grown, and the egg-bearing, have caused much concern, and led to the enactment of laws limiting the size and prohibiting the catch of those bearing eggs.

To put back into the water all below a fixed limit cannot largely increase the stock, but must have a favorable effect, as it gives those that have passed through the most hazardous period of life a chance to attain to a mature size. While the taking of the egg-bearers is a draft upon future stock, and if they could be returned to the water and allowed to remain there until the eggs were hatched, little more could be accomplished in the way of assisting nature in keeping up the stock.

The efforts made to enforce legal enactments to secure these ends have failed; they have succeeded only in creating a conflict between those charged with the enforcement of the law and the fishermen, and in the expenditure of large sums of the State's money.

The restrictive laws are often evaded, and never effective in accomplishing the purpose expected. While they may restrain a few, the majority will destroy the eggs to avoid the penalty, and retain the lobster for market.

We do not mean here to impute to the fishermen any special lawlessness beyond that of other classes. Most people are willing to escape taxes; very many constantly evade them; and the fishermen look upon anything taken from their catch as a tax. Each egg-lobster means to them about twenty-five cents, and is it a matter of surprise that they don't voluntarily drop overboard an indefinite amount of quarters of dollars.

We make no apology for those who break the law. It is our wish to point the way to a practical method of dealing with the question.

We have said that the laws were ineffectual; it would be easy to show that they are, but we believe it generally admitted that they are, even where wardens are charged with their execution as their sole duty, and with every facility for their work.

How to secure the end contemplated by the laws, and make practical efforts to sustain or increase the stock, is the question.

We suggest the following as the only possible method that appears practical to us:

The State to purchase every egg-lobster caught, and either replace them in the water, where they would not be recaptured, or retain them until hatched.

To put in effect the plan proposed and carry it to a successful issue, there should be a co-operation of the different States and that of the General Government, and should be on some general and systematic plan.

COST.

We believe the efforts to enforce the laws in some of the States have been at a cost to the State of very much more than enough to purchase every illegal lobster taken. We are without data, but doubt if the estimate of twenty-five cents per pound is too high, while the same might have been bought for six or seven cents per pound.

Besides the evil effects of a continued warfare is very demoralizing. It makes poachers and law-breakers of many otherwise well-disposed citizens, and engenders bitter enmity where good feeling should exist, that would lead to co-operation.

We think that if the fishermen were paid for the egg-lobsters sufficient to compensate for any extra trouble, they would gladly turn them in to the State, and co-operate with officers to enforce the laws limiting size.

Even if it became necessary to purchase the short lobsters, it is a question if the State could not, then, secure the end desired cheaper than by any other method. This we say would be very much more effective and at less cost to the State, than an army of officers or a flotilla of gunboats.

To secure and return to the water as young life, every egg carried by the lobsters, would promise very much more than has been done heretofore.

We were much gratified that a neighboring State tried, last year, the plan of buying the egg lobsters, although we have not learned how satisfactory they were in hatching them. We are very sure many eggs were returned to the water as young, that would have otherwise been destroyed.

HATCHING.

We believe no method better than that provided by nature, and if practical to place the egg lobster in the water free, where they would not be again captured, in no way could more be done to increase the future stock. Next to this we would retain the lobsters until hatched and thereby secure a young lobster for every egg. By incubation with any process we believe a great waste occurs; first, in stripping the eggs, then in hatching, and again, a loss occurs after hatching, before they are liberated. Besides, this entails considerable labor and expense.

PRESERVES.

That lobster and fish preserves may be established where most of our edible fishes could be kept under nearly natural conditions, and where they could be retained for long periods, and some of them continuously, we verily believe.

The advantages of such a preserve must be obvious to all. The very large catches that glut the market for short periods and are soon followed by a scarcity, need never occur; the bulk of the large catches could be placed in the preserves and used as wanted, or furnish sport for the hook and line fishermen.

Were we not convinced of the feasibility of this method we should hardly have ventured to present it here.

There are along our coast arms of the sea or partially enclosed waters, that furnish every natural condition required for some or other of our fishes. Could entire control be secured of some of them, we believe the results would justify any cost that would be necessary to test them by a fair trial.

We trust that the Fish Commissioners of the Atlantic States and the United States will give this matter an investigation and report as to to its practicability.

J. M. K. SOUTHWICK, *Chairman.*

State of Rhode Island in account with Commissioners of Inland Fisheries:

1894.	**Dr.**	
Dec. 31.	To balance due Commissioners	$632 63
1895.		
Mar. 7.	" paid for trout fry (50,000)	101 50
Oct. 30.	" " " yearling trout (10,000)	400 00
"	" " " transportation cans	24 00
Dec. 31.	" expenses of Commissioners	107 78
"	" printing, advertising and postage	28 75
		$1,294 66
1895.	**Cr.**	
Mar. 4.	By cash of State Treasurer	$632 63
May 28.	" " " " "	146 34
Oct. 29.	" " " " "	442 14
Dec. 31.	" balance due Commissioners	73 55
		$1,294 66

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
CHARLES W. WILLARD,
ADELBERT D. ROBERTS,
Commissioners of Inland Fisheries.

LIST OF FISH COMMISSIONERS.

The United States.

Commissioner, ——— Brice.

Richard Rathbun, Assistant in Charge of Division of Inquiry respecting Food Fishes.

W. de C. Ravenel, Assistant in Charge of Division of Fish Culture.

Hugh M. Smith, Assistant in Charge of Division of Statistics and Methods of the Fisheries.

Herbert A. Gill, Chief Clerk and Acting Commissioner.

Alabama.

Col. D. R. Hundley,	Madison.
Hon. Chas S. G. Doster,	Prattville.

Arizona.

T. W. Otis,	Prescott.
John Howard,	Prescott.
C. W. Stearns,	Phenix.

Arkansas.

H. H. Rottaken, President,	Little Rock.
W. B. Worthen, Secretary,	Little Rock.

This State has never made an appropriation for fish culture.

California.

H. F. Emeric, President,	San Francisco.
William C. Murdoch,	San Francisco.
J. M. Morrison,	Sacramento.

Colorado.

Gordon Land,	Denver.

CONNECTICUT.

Hubert Williams, President, ... Salisbury (Lakeville P. O.).
Abbot C. Collins, Secretary, ... 291 Main Street, Hartford.
James A. Bill, Treasurer, ... Lyme (Bill Hill P. O.).

The Shellfish Commissioners are: George C. Waldo, Bridgeport; Bryant A. Treat, Wallingford.

DELAWARE.

Charles H. Shubert, ... Odessa.
Dr. E. G. Shortlidge, Supt. of Hatcheries, . Wilmington.

GEORGIA.

R. T. Nesbitt, ... Atlanta.
Capt. J. D. Edmondson, ... La Grange.

ILLINOIS.

Richard Roe, ... East St. Louis.
Geo. H. Langford, ... Havana.
Henry Schmidt, ... Elgin.

INDIANA.

P. H. Kirsch, ... Columbia City.

IOWA.

Geo. E. Delevan, ... Estherville.
Ole Bjorenson, Superintendent.

KANSAS.

O. E. Sadler, ... El Dorado.

MAINE.

Thos. H. Wentworth, ... Bangor.
Henry O. Stanley, ... Dixfield.
O. B. Whitten, Sea and Shore, . . . Portland.

MARYLAND.

G. W. Delawder, ... Oakland.
G. R. Rider, ... Salisbury.

MASSACHUSETTS.

E. A. Brackett, Chairman,	Winchester.
I. C. Young,	Wellfleet.
E. D. Buffington,	Worcester.

MICHIGAN.

Herschell Whitaker, President,	Detroit.
H. W. Davis,	Grand Rapids.
Seymour Bower, Superintendent,	Detroit.
Geo. D. Mussey, Secretary,	Detroit.
F. B. Dickerson,	Detroit.

MINNESOTA.

W. S. Timberlake,	St. Paul.
Wm. Bird,	Fairmount.
W. P. Andrus,	Minneapolis.
A. F. Ferris, Secretary,	Brainerd.
F. von Baumbach,	Alexandria.
S. S. Watkins, Superintendent,	St. Paul.

MISSOURI.

H. M. Garlichs, Chairman,	St. Joseph.
J. L. Smith,	Jefferson.
Edw. Cunningham,	St. Louis.
A. C. Garlichs, Secretary,	St. Joseph.
Philip Kopplin, Jr., Superintendent,	St. Louis.
James W. Day, Superintendent,	St. Joseph.

NEBRASKA.

Joseph H. Blair,	Omaha.
William L. May,	Omaha.
R. H. Oakley,	Lincoln.
M. E. O'Brien, Supt. of Hatcheries,	South Bend.

NEVADA.

Geo. T. Mills,	Carson City.
Ernest Harris, Deputy,	Carson City.

New Hampshire.

W. T. Shurtleff,	Lancaster.
W. H. Griffin,	Manchester.
Nathaniel Wentworth,	Hudson.

New Jersey.

George Pfeiffer, Jr.,	Camden.
Parker W. Page,	Summit.
W. Campbell Clark,	Newark.
Howard P. Frothingham,	Mt. Arlington.

New York.

Barnet H. Davis, President,	53 Broadway, New York.
Henry H. Lyman,	Oswego.
William R. Weed,	Potsdam.
Charles H. Babcock,	Rochester.
Edward Thompson,	Northport.
F. B. Mitchell, Secretary,	Albany.
Edw. Thompson, Shellfish Commissioner,	53 Broadway, New York.

Ohio.

H. B. Vincent, President,	McConnellsville.
Wm. R. Huntington, Secretary,	Cleveland.
J. W. Owens,	Newark.
B. F. Seitner,	Dayton.
E. B. Shorb,	Van Wert.

Oregon.

H. D. M'Guire, Fish and Game Warden.

Pennsylvania.

Henry C. Ford, President,	1823 Vine Street, Phila.
James A. Dale, Corresponding Secretary,	York.
H. C. Demuth,	Lancaster.
S. B. Stillwell,	Scranton.
Louis Streuber,	Erie.
D. P. Corwin,	Pittsburg.

RHODE ISLAND.

J. M. K. Southwick,	Newport.
William P. Morton, Secretary,	Johnston.
Henry T. Root, Treasurer,	Providence.
Chas. W. Willard,	Westerly.
A. D. Roberts,	Woonsocket.

SOUTH CAROLINA.

Hon. A. P. Butler,	Columbia.

TENNESSEE.

W. W. McDowell,	Memphis.
H. H. Sneed,	Chattanooga.
Edward D. Hick,	Nashville.

UTAH.

A. Milton Musser,	Salt Lake City.

VERMONT.

John W. Titcomb,	St. Johnsbury.
Horace W. Bailey,	Newbury.

VIRGINIA.

Dr. J. T. Wilkins,	Bridgetown.

WASHINGTON.

James Crawford,	Vancouver.

WISCONSIN.

Edwin E. Bryant, President,	Madison.
Calvert Spensley, Treasurer,	Mineral Point.
William J. Starr,	Eau Claire.
Prof. E. A. Birge,	Madison.
Jas. J. Hogan,	La Crosse.
Geo. F. Peabody,	Appleton.
Currie G. Bell,	Bayfield.
Jas. T. Ellarson, Secretary, Fish and Game Warden,	Madison.

WYOMING TERRITORY.

Louis Miller,	Laramie.

APR 20 1897

State of Rhode Island and Providence Plantations.

ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1897.

PROVIDENCE:
E. L. FREEMAN & SONS, STATE PRINTERS.
1897.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1897:

The Commissioners of Inland Fisheries herewith present their report for the year 1896.

TROUT.

Thirty-three thousand (33,000) trout fry and about nineteen thousand (19,000) yearling trout has been purchased and distributed in the various waters of the State.

Trout fishing during the past season has been reported to us as better than last year.

LAND LOCKED SALMON.

The Commissioners have received notice from United States Fish Commmission of an allotment of three thousand (3,000) eggs of this species; these will be hatched and reared until a year and a half old, and distributed in waters adapted to them.

BAY FISHING.

The fishing in the upper waters of the bay has been even better than last year.

LARGE MOUTHED BLACK BASS.

(*Micropterus-Salmoides.*)

The Commission has the past season given some attention toward the propagation of this species of Black Bass believing that it will prove a valuable addition to the inland fisheries of the State.

A body of water located within the town of Westerly, has been set apart for this purpose with the consent of the Town Council, and will be used exclusively for the cultivation of this variety of game and table fish. Two consignments of fish have already been received and planted in this preserve; one, August 4th, of six hundred (600) and one, November 4th, of fifteen hundred (1,500) both from United States Fish Commission.

In from two to three years these fish will have increased sufficiently to enable the Commission to commence the work of stocking many of the ponds and rivers of the State.

The large mouthed bass is native to the Great Lakes, the rivers of the Mississippi basin, and nearly all the waters of the Southern States.

In New England it is comparatively unknown, the small mouthed being perhaps better adapted to the clear cold waters of most of our lakes and ponds and has consequently received more attention.

There are however in this State many waters that are better adapted to the large mouth species, for instance, in large shallow ponds or lakes of comparatively high temperature and in rivers with sluggish current and muddy bottom, also in rivers that are somewhat polluted by refuse from mills, etc. It is this class of waters particularly that the Commission hopes to largely benefit by the introduction of this species.

As a food fish the large mouth bass rank among the first of the fresh water fishes; its flesh being firm and white, and when properly cooked, tender and juicy.

As a game fish it is fully equal to its relative the small mouth, when taken in the same waters and under same conditions. And upon good authority it can be claimed that it is a much more ready biter, rising freely to the surface of the water for natural bait or artificial fly. The small mouth, on the contrary, as many anglers can testify, is extremely epicurean in his tastes and on the whole a very uncertain biter.

In point of size, the large mouth is certainly the superior of all varieties of the fresh water basses of this country, attaining in some waters the enormous weight of eighteen to twenty pounds, whereas the largest specimen of small mouth of which there is any authentic record weighed but eight and three quarters pounds.

SMALL MOUTHED BLACK BASS.

(*Micropterus-dolomieu.*)

The fishing for this variety the past season has not been equal to that of the previous season. This fact is not taken as evidence that the fish are decreasing, but is probably owing to low water in many of the ponds during the best part of the fishing season.

Realizing that there are many ponds and streams in the State well adapted to this species and which are as yet unstocked, the Commission has leased a small preserve near Niantic and has stocked the same with adult fish. These fish spawned in May and it is estimated that there are now several thousand young bass in the pond, which are doing well. These fish will at the proper time be transferred to waters hitherto barren of this variety of food fish.

SEA FISHES.

The last season has been remarkable for the number, easy and large capture of most all varieties. Any and all methods of capture have been successful. Even by hook and line have large numbers been taken. The low prices that have generally prevailed throughout the season, have alone prevented a very large harvest to the fishermen.

We believe we cannot better present the season's fisheries than by quoting from our local and other papers as follows:—

CODFISH SWARM IN SCHOOLS OFF THESE SHORES.

Fishermen in this vicinity who have followed their vocation for years, report that this year's run of codfish is the largest that they ever saw. Captain Covo, with three others, took 1,000 pounds of fish in four hours while anchored at a point a half mile south of the lightship recently.

The fish are of smaller size than usual, but are more abundant than ever they were before. They average about five pounds in weight, which is just about half their usual size. A fish weighing fifteen pounds, this season, is almost a curiosity, while one weighing fifty pounds, such as has been caught in former years, is now of very rare occurrence. The fish are so plentiful, an exchange says, " that wagons have been loaded from the rocks on the shore at Beaver Tail by the farmers of Jamestown."

The favorite bait is a small herring about five inches long, and large clams and quahogs. The former, however, is preferable by reason of it being less susceptible to the attacks of other fish.

The fish are now working westward, the season in the vicinity of Beaver Tail lasting usually from November 10th to the 1st of December. After December 1st they will be found in the deeper waters off Point Judith, and later, in the still deeper waters off Block Island.

THE FISHING SEASON.

The fishing fleet still lingers in these waters and those of Block Island, but the number of craft is very small compared with the big mackerel fleet. The superabundance of fish of all kinds this season has stopped all the talk that the local fishermen once had about the dumping of the local house offal off the lightship. To this was ascribed the scarcity of fish at one time. The swill is still dumped off the lightship, but the fish were probably never before so plentiful off Newport and Block Island, and hauls have been made with hand lines and seines that put the glowing stories of old time fishermen far in the shade. The menhaden fishermen have also had a good season, one firm reporting the catch of 37,000 barrels. The price, however, of both fish oil and guano is so low that very little profit is made on the season's work, which is now over.

CODFISH IN PLENTY.

Codfish have succeeded mackerel in the waters about Newport and Block Island, and their number is legion. Last night fishing schooner Dauntless brought in fifty-seven barrels of school cod from the trap near Narragansett Pier, and to-day brought over forty barrels more. Last night a school was seined off the bathing beach at Block Island, and a large haul was towed ashore on the beach, from which twenty-five barrels were to-day shipped on the Danielson. This is the first time in the memory of the oldest fishermen that a seine full of codfish was hauled ashore on the beach. This fish is usually found further from the shore, but this season can be caught like black fish, right up to the rocks along the coast. The mackerel are thinning out, after a season of unprecedented supply.

FISH BY THE TON.

Wonderful Catches off the Jersey Coast Reported.

ATLANTIC HIGHLANDS, N. J., November 25.—All fishing records from Sandy Hook southward below Highland Beach are being broken. Fish are being caught by the ton. Such swarms of all kinds of the denizens of the sea have never before been known, even to the oldest fisherman hereabout. Whether it be the warm weather or the break at Sandy Hook allowing a free flow of sea through the new channel, or what, it is certain that the fishermen never before revelled in such quantities and variety of fish.

So great has been the supply that fish of all kinds bring at wholesale only 1 to 1½ cents per pound. This town and adjoining villages are glutted with fish. People are becoming nauseated from eating fish so often. Wagon load after wagon load has been disposed of inland, and though selling cheaply the fishermen have made considerable money. The fish have been shipped by rail or boat to nearby cities, and yet the supply is greater than ever. They are given away here to those who will take them.

Captain N. B. Church from New York under date of December 1st, 1896, writes:

"I am always willing to give you any information I may have regarding the fisheries. Let me say with all possible emphasis that food fish of all the native species have been abundant on the Atlantic Coast. That none of the common varieties can be selected that the market has not been full of, at almost any time during its season. Any one that wants a fresh codfish in this vicinity to-day can get it by going down on the coast with a rake, or hook and line, something I have never known before."

"The menhaden business as a whole has been much more profitable than last year. There was a fair run of this fish in our section early in the season, also in Buzzard's Bay, but none on Maine Coast.

The body of menhaden have been located between Sandy Hook and Delaware Bay and the body has been a very large one and the fish fat."

Mackerel have been exceedingly plenty this season, and the largest catch ever known here has been made. Since early summer they have been constantly in our waters until November. The average has been small in size, but we know of one that was 18½ inches.

The following from *N. Y. Herald* gives a correct idea of the abundance of these fish:

A BIG RUN OF MACKEREL.

For some reason not altogether accounted for there has been a greatly increased mackerel catch during the season just closing, and unprecedentedly large schools have made their appearance in some places. This has brought the supply of fish up and prices down.

There have been large schools of mackerel off the Long Island shore. Sunday the waters about Far Rockaway were filled with these fish, and the sport of catching them was entered into by all the summer sojourners. A single boat, with one net, in a few minutes caught enough to nearly swamp the craft. But most of the catch were small fish. In places in Jamaica Bay the waters were fairly blocked by the fish, and fishermen landed more than have been caught in years before along the entire coast.

From all along the coast between Hatteras and Nova Scotia, comes the story of big schools and large catches. The fishermen of Nova Scotia say they are taking twice as many as during any season in the last six years. From Newport comes the information that three mackerel are now being caught for every one taken during the past seven years. One of the largest catches ever made at Newport was in 1890, and the present year has eclipsed that record.

Fish dealers doubt that the closed five years during which mackerel could not be caught with a net, has had the effect of bringing the present increase. For five years previous to June 1, 1894, the United States statute forbade the taking of mackerel by net, and when the season of 1895 opened it was thought the catch would be large, but it was not. Now, however, the mackerel are very plentiful, and in waters where the United States statute did not operate.

"There is no accounting for the great increase in mackerel," said a well known Fulton Market fish dealer. "I don't think the law had anything to do with it. The supply is practically inexhaustible. It is only a question of the fishermen looking in the right places and having favorable weather. For some years the catch has been small, because the larger schools have not been reached and the supply was so low that many dealers went out of the mackerel business and thousands of consumers went without the fish. Now the supply has come up to the demand, but not beyond yet, for the demand for mackerel is an enormously large one."

Inquiry about the market develops the fact that ten years ago the supply of mackerel was so large that after the market was supplied at the lowest possible price, each day loads of the fish were emptied into the garbage scows. Then the supply began to fall off, and the past seven years it has not been nearly equal to the demand, and prices have been high. A strange thing is that during these years of scarcity, the fish that were caught were large in size, running from one to three pounds each, while now five or six combined weigh a single pound.—(*New York Herald.*)

We copy the following description of a new way to take mackerel:

NEW WAYS OF TAKING MACKEREL.

The fall run of mackerel at Block Island is unusually heavy. The fish are large, too but so shy that the old ways of taking them with hook and line, drift nets, and seines, each of which proved successful in its turn, have failed. About four years ago the eastern mackerel fishing fell off largely for this reason. This year the fish are more plentiful than ever, but they are just as cunning, and while the catch exceeds by far the catch for the same period of last year, the number of fish taken is as nothing compared with the number of fish seen.

Many of the mackerel that are now being taken by the Block Island fleet of mackerel schooners are caught by an entirely new device. The tools are two long poles affixed to the schooner's side, a deep, loose square bag net of fine mesh, and plenty of "stosh," or fish bait. One of the poles is swung out from the starboard fore rigging like a boom. at right angles to the vessel and on a level with the deck. This boom is twenty-five feet long. At the same time the second pole, which is a trifle shorter, is swung out near the main rigging in a similar manner. The bag net is stretched on these booms, which are placed about thirty-five feet apart. This distance is the length of the net on its inner edge. The outer edge is made fuller and is weighted with lead sinkers. When all is ready for use the after boom is lowered down until its outer end and most of the net are concealed under water. Freshly ground stosh is thrown into the capacious maw of the hidden bag, the mackerel rush for the bait, and when they swim thickly enough the after boom is hoisted until the outer edge of the net is above water and the fish are imprisoned. The fish are then bailed aboard the vessel. The old fishermen assert, however, that the true mackerel are not taken by this device, as they get away promptly at the first upward move of the net, but the voracious bull's-eye mackerel fall an easy prey. The schooner Stowell Sherman took 165 barrels of mackerel in this way the other day, and all the mackerel craft hereabout have been or are being equipped with the new apparatus.

A novel device that may lead to the entire revolutionizing of the mackerel fishing is to be tried here in a few days upon the arrival of the steamer Bradley from Provincetown. Her commander, Jonathan Chase, has contrived an electrical apparatus which, he thinks, will lure the mackerel. He has a dynamo in his boat to which is attached a long wire supporting from one to six incandescent light bulbs. These bulbs will be lowered into the depths and the lights turned on. This, it is believed, will draw the mackerel by night in such numbers as to make the selling of them easy and profitable.—(*Block Island letter in New York Sun.*)

SQUETEAGUE.

These fish have of late years been very abundant, and very regular in their visits to our waters. They seem to have in a measure taken the place formerly held by their colleagues the blue-fish, whom they resemble in their habits, both being very destructive of other fish.

Why the blue-fish remain in the waters about Block Island, and very plenty farther west, and cease to come here in numbers, is a problem we at present cannot solve.

We are indebted to the representatives of the transportation companies for the following valuable statistical data, which is the only essentially correct data that can be got, and if continued it will give a very correct idea of the relative catch of fish from year to year. While this does not give a sure guide to the gross product, it is certainly correct and reliable as far as it goes; and we prefer to give it, rather than depend on the usually questionable way of making up statistics from rough estimates or guesses.

Of course there is a large amount shipped by sailing crafts of every description, besides the home consumption of which we have no means of getting accurate account.

We are enabled this year to present the following table made up from data kindly furnished by the various transportation companies, and shows the entire shipment by all regular lines from Newport, during the year:

	FISH. Barrels.	LOBSTERS. Barrels.	SWORD-FISH. Number of Fish.
January	273	12	...
February	81	1	...
March	47	3	....
April	154	58	....
May	7,713	287	....
June	7,179	374	42
July	2,184	548	95
August	1,824	576	....
September	6,257	146	6
October	3,301	54	...
November	868	22	....
December	56	34	....
*Express	1,127		...
Total	33,064	2,115	143

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* From June 1 to December 14.

To show the comparative shipments over the Old Colony Steamboat line we continue our table.

YEAR.	FISH.	LOBSTERS.	TOTAL.
1886	......	.....	17,434
1887	16,657	834	17,491
1888	15,033	1,161	16,194
1889	19,306	2,047	21,353
1890	8,933	2,650	11,583
1891	18,032	2,204	20,236
1892	26,832	2,123	28,955
1893	24,452	1,399	25,851
1894	17,769	2,392	21,161
1895	24,622	2.119	26,741
1896	20,425	1,728	22,153

LOBSTERS.

The last has not been a very productive season for lobsters.

We have retained a number of egg lobsters until they hatched, but have not made any attempt to hatch by artificial incubation, being satisfied by past experience that the waste by that method is too large to justify its continuance. The claims made for the incubators of hatching 90 per cent., we feel sure could only be made by rough estimate and no allowance can be made for large numbers that die (before they are removed from the incubator) or before they are liberated.

That the method in use at Wood's Hole is much more successful we cannot doubt, but that any method can be made to approach that of nature we cannot believe. And as it is possible to retain the egg lobsters until the eggs are hatched, we are very much in favor of that method as the most practical one of aiding nature to preserve the product of the eggs.

The following article taken from the *Spectator* has so pertinent an application to our fisheries, that we give it here with our hearty endorsement, and commend its teachings to all having to do with the fisheries, in efforts for their promotion:

THE PRACTICAL STUDY OF FISH.

The Lancashire Sea Fisheries Joint Committee are about to establish a Marine Laboratory on Rod Island, near Barrow-in-Furness, for the scientific and practical study of the life and habits of sea fishes. The new Laboratory will be under the direction of Professor Herdman, and will take the place of that at University College, Liverpool. In evidence of the success of similar institutions we may quote from the history of that established at Plymouth in 1888. Various Commissions on Trawling and Fisheries, mainly with a view to inquiring into the damage or decrease of fisheries, had found that they were working absolutely in the dark. Every one knew all that needed to be known about nets, gear, boats, stores, fishing, and marketing. But no one knew anything worth knowing about the fish. When questioned, the practical fishermen could give no practical information. They did not know where the migratory fish came from. They were equally in the dark as to where they went to. They did not know why they came, or why they went. They wanted to stop trawling on "spawning-beds." But trawlers denied that the fish in question laid eggs on spawning-beds at all. It was scarcely fair to prohibit trawling over ground at the bottom of the sea for fear of injuring eggs which might be, and as it now appears are, floating on the surface. Nothing was settled as to the food of the herrings, pilchards, and non-carnivorous fish, and when a cry was raised to protect "immature fish" it was discovered that no one knew when a sole or a turbot was "mature." In America trial had been made of the habits of a limited number of fish, and immense hatcheries established, with one striking result. The cod at certain times leave the shores of New England to visit the colder waters of Newfoundland. The millions of young fish turned out in the hatcheries had established a race of non-migratory cod, remaining on the coast, and these formed a regular object of a fishery, fishery, and named by the trade "Commission cod." But something more than a machine for producing young fish was needed, —an institution which might stand in the same relation to the national marine wealth and the history of fishes as Kew holds in regard to the vegetable produce of the Empire and the natural history of plants. In any case, the scientific and practical side must be associated, if only, as Professor Ray Lankester urged, because no such distinction could possibly be drawn, and to ignore scientific methods was to court practical failure. The marine "Kew" took shape at Plymouth, in the building erected by the Marine Biological Association, and maintained partly by a Government grant of £500 per annum, but mainly by the subscriptions of the members. This thoroughly English proceeding of undertaking a national work by private persons convinced of its necessity deserves credit and practical support. Its tables and tanks afford to the biologist opportunities for studying at first hand examples of evolution more finely graded, more numerous, and more coherent among the swarming creatures of the sea than among the less numerous and less varied creatures of the land. For those to whom habits rather than structure are an object of curiosity, the services of the local fishermen are engaged to note the movements of the fish, the depths at which they are found, the nature of their food, the use of artificial in place of natural bait, the times at which the fish are spawning, and the nature of the ground on which they lie. The scope of its inquiries must range from the deep Atlantic, to see whether or not it is there that the pilchard shoals disappear, to the inlets of Plymouth Sound, and the effects of sewage upon local fishes. And lastly, it must possess an intelligent director, with ample means at his disposal for capturing, keeping, and observing all sea creatures and products, from a full-grown conger to the egg of the sole. The Journal of the Association is rich in interesting experiments and discoveries from its first to its latest number, and yet the work of discovery in this great half-explored region of our populous shallow seas is only in its beginning. Nor can this be matter for surprise when our ignorance of the habits of migratory river fishes is such that it was not until 1896, and then as a novel and striking discovery, that the President of the Royal Society announced that Professor Grassi had at last discovered that the river eels, whose method of reproduction had been a mystery since the days of Aristotle, never breed till they go to the sea,—a discovery made partly owing the aid of the classic Charybdis, whose currents threw up the breeding eels from the deeps in which they are hidden. This would doubtless have been discovered long ago had the eels not reversed the process used by the salmon, and gone to the sea, instead of ascending rivers, to breed. On the other hand, it is evidence in itself of the difficulties in the way of marine zoölogy. Almost the first discovery made at the Laboratory bore directly on the great question of the appearance and whereabouts of the eggs of many food fishes of the sea. This was the work of Mr. J. T. Cunningham, the naturalist of the Association. Everybody knows that the salmon and trout and most river fish have regular spawning-beds, sometimes dropping the eggs on rough gravel and sand, which some fishes, such as lampreys, pile up in order to break the force of the current, sometimes, as in the case of many coarse fish, sticking them on to weeds and piles by the locks and weirs. If the sea fishes caught for food did the same, as was commonly believed, protective legislation and much interference with trawling might have been necessary. In a very short time Mr. Cunningham, unequipped with a steam-launch, and only able to make excursions with the local fishermen, was able to write as follows:—"The eggs of nearly all our food fishes, except the herring are *buoyant* and *transparent* when they are ripe. The immature eggs when in the ovary are opaque white grains; but by the time they are shed they become as transparent as glass. These ova, as soon as they are shed, are fertilised by milt in the water, supplied by male fish in the neighbourhood, and then rise to the surface of the sea; in calm weather only do they actually reach the surface, because, being but slightly lighter than the water, agitation causes them to be uniformly distributed throughout the depth affected by wave motion." Thus in a few lines the writer was able to correct a natural mistake as to fact which might have caused mischief and wrong legislation, and to describe a most beautiful device of Nature by which these millions of eggs are rendered invisible, locomotive, separate, and safe from local destruction. In addition, he identified the eggs of the common sole, and found that, were it desired, millions of young lemon-soles and mackerel might be hatched from eggs contained in the fish caught for market. Equally important data were obtained at Plymouth on the rate of growth of sea fishes, and on the size and age at which they spawn. This had only been attempted successfully in the case of one species, the cod. The results give safe ground for the discussion of the limits of size below which these fish should be protected. Reports from the fishing boats and fleets give the catches at different seasons, the nature of the ground, state of the wind and weather, and in the lobster-fisheries the proportion of the different sexes. Interesting experiments on the use of artificial baits are recorded, and careful notes made on the larval stage of soles and other marine fish.

Perhaps the most curious of the recent results of the experiment made at the Laboratory has been the confirmation of the common, but almost incredible, belief that soft and helpless starfish can open oysters, and that they must therefore be carefully weeded out from the beds. The starfish throws itself over the oyster, folding over the shell on either side like a pair of clapsed hands. It then sets up a steady strain by means of its suckers, a strain which apparently causes it little effort, while the exertion of "holding the door" at last wears out the oyster. By fixing a weight fastened to strings connected with each shell the strength developed by the starfish to open the oyster has been calculated, and the pulling force by which this strange conquest is achieved determined. The Laboratory is also in touch with that at St. Andrews, and with the Liverpool Laboratory, now about to be transferred to the coast. Norway, France, and above all, Italy, at Naples, possess institutions of a similar kind in a high state of efficiency, and by comparison and division of labour the whole history and wanderings of the migratory fishes will before long be mapped out and available for the use of the fishing fleets of Europe. We half wonder that some one does not pity the fish, but pity stops at the water's edge; and even John Bright was an angler.

RANGES FOR FISHING GROUNDS.

The following were copied from a memoranda book written in the early part of this century and may be of interest at this day, although some of the land marks have disappeared:

Easton's Point.

Hanging rocks and Gardner house, Joshua Peckham's house and barn, just clear Easton's point land.

Memoranda, good fishing ground about six or eight rods southward of the sheep pen.

Ranges on Coggeshall's Ledge.

Walter Easton's house, and the north end of Gull Rock, Church steeple and boat house.

Inner Ground.

Walter Easton's house and Coggeshall's bass rock, Church steeple and Sheldon's Point.

Seal Rock and Light house and Walter Easton's and Gull Rock.

Pool.

Church steeple and east side of the boat house at the ledge.

Colling's house over a certain rock on the north part of Price's Neck.

RANGE OF FISHING GROUND AT THE FLAT ROCK.

The great rock at rough point over the high part of the flat rock, and certain high bunch of trees on Gooseberry Island, towards the north part over the opening between the ledge and Sheldon's Point.

Second middle ledge the west side of the West Island in range with Mount Hope, the church steeple over the high part of Comorant Rock.

Other Part.

Church steeple as before Comorant Rock with Mount Hope.

Gulf Rock Ledge.

Turn Peas Rock with Easton's boat house, the high gray part of the Gull Rock with the end of the fence that leads down to Sheep Point.

Other Part.

Southwick's house in range with Moon's Lane by Cozzen's house, a light colored rock just back of the Black Flat Rock near the spring in range with Church's chimney.

Other Part.

Southwick's house and Moon's lane, and the end of the wall next the Fell Rocks and Church's house.

FISHING LEDGE FOR TAUTOG.

South-west part of Cuddyhunk with Gay Head.

South-west part of Pennykies with Quixes hole, eight and one-half fathoms.

Carge's Ledge off against Gooseberry Island. The east side of Island Rock at west end Coggeshall's Beach, with Amy's house, and Rocky Farm house with Mr. Hopkin's steeple.

Range for the Fountain.

The Black Rock with ten fathoms, Collins house the Black Rock. The light house with the grove next northward of Tower Hill, and with a high bunch of trees near the middle of it; or late in the fall let Collin's house range with the east side of the rock about twelve fathoms. Good in September for blue-fish and succoting and late in the fall for cod and tautog.

Shole Nub (Knob).

The high rocks southward of Castle Hill, with a white clift to the southward of dumplings and Rocky Farm house just over the south-east part of Gooseberry Island and south-easterly from that for one-half mile.

BROKEN GROUND FALL COD AND TAUTOG

Scup Ledge.

The high part of the outermost rock at Saconett Point just within Cormorant Rock and Cozzen's house.

Easton's Point in range with a tree, the top only appears when on the ledge, nine to ten fathoms. July and August large fish.

Cormorant Inner Shole.

North-east corner of Easton's orchard in range with the windmill, a large tree in Saconett to range just on the south-west of Sachuest or the windmill over the hollow on Cormorant Rock.

Other Part.

James Easton's buttonwood tree in range with the buttonwood tree by the mill north-west of Church's orchard just within the high part of Cormorant Rock; a few trees over the low part of the rock.

Cormorant Rock Ledge.

A house on Saconett a little above the bunch of large trees with the high part of the Island Rock where it closes with Sachuest Point, a large tree by the mine about a rod to the mill on the hill aboveit, and east and west from that good tautog ground.

The large tree on Saconett with the high part of Cormorant Rock; the church steeple two or three rods, or Taylor's orchard, or a large tree by the mine on the western part of the mill above it.

Same ledge. The church steeple two or three rods clear of Taylor's orchard, the bunch of large trees above the large tree on Saconett with the low south-eastern part of Cormorant Rock. Benjamin Church house, Flat Rock, the high part of the rock with a high rock on the land, the north-western part of Gooseberry Island between the ledge so as the trees just to appear, light-house just in range Shole Nub on Price's Neck.

Coggeshall's Ledge.

No. 1 Range.

Walter Easton's house between north-west part of Gull Rock and Stanton Rock, and half way on Stanton Rock; the south part of Collin's house with the north-east part of a rock to the eastward of Price's Cove. Good for cod and tautog in the fall.

Other Part, No. 2.

W. Easton's house over the north-western part of the Gull Rock, the church steeple just clear of Ledge Point, meeting house steeple over the high part of Ledge Point on the shore.

No. 3.

The light-house just to the southward of Seal Rock, the meeting house steeple just clear of the high part of ledge. November, cod and tautog.

No. 4, Out Shole.

Freebody's boat house in range with the meeting house steeple. Collin's house on the high north-east part of the rocks on Price's

Neck against a white clift, the barn part clear of the high part of the rocks, the light house about six feet to the north-west west of the highest part of a grove on Narragansett.

No. 5, Late and Early.

The church steeple with Freebody's boat house, and just eastward of it, and Collin's barn the whole of it on the north-west part of high part of rocks on Price's Neck. Seven to ten fathoms or more, but for tautog late and early, or late as the middle of December.

Ledge South of Seal Rock.

The high rock south of Castle Hill, with a white cliff to the southward of the dumplings and Rock Farm house just over the south-east part of Gooseberry Island and south-easterly from that, for one half mile. Broken ground fall cod and tautog.

Good Fishing on Cormorant Ledge.

Ranges. Comorant Rock with Church's house, (the lowest on Saconett,) Seener's Point to open a remarkably large tree on Saconett with a small one by it. Hubbard's mill with Easton's orchard two or three rod from ye New England part.

State of Rhode Island in account with Commissioners of Inland Fisheries:

	DR.	
1895.		
Dec. 31.	To balance due Commissioners	$73 55
1896.		
Apr. 6.	To paid for 33,000 trout fry	82 50
“	“ “ 19,000 yearling trout	658 88
“	“ “ seine	11 98
“	“ “ brown trout eggs	7 04
Dec. 31.	“ “ expenses Commissioners	207 24
“	“ “ printing, advertising and postage	5 40
		$1046 59

1896.	CR.	
May 2.	By cash of State Treasurer....................	$227 00
Oct. 15.	" " " "	615 88
Dec. 31.	" balance due Commissioners.................	203 71
		$1046 59

J. M. K. SOUTHWICK,
HENRY T. ROOT,
WILLIAM P. MORTON,
CHARLES W. WILLARD,
ADELBERT D. ROBERTS,

Commissioners of Inland Fisheries.

29,150

State of Rhode Island and Providence Plantations.

TWENTY-EIGHTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1898.

PROVIDENCE:
E. L. FREEMAN & SONS, PRINTERS TO THE STATE.
1898.

[illegible]

State of Rhode Island and Providence Plantations.

TWENTY-EIGHTH ANNUAL REPORT

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1898.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1898:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1897.

It has been estimated by the United States Fish Commission that the fisheries industries of the State of Rhode Island represent an invested capital of over $1,000,000; yielding an annual income of more than $700,000, and furnishing employment to fifteen hundred people. An industry offering employment to so large a number of our citizens, and bringing, at the same time, large sums of money into the State, should be fostered with the utmost care; its condition should be critically examined; ample records should be kept; prejudicial factors should be detected; errors corrected; and active measures should be taken to still further develop what has been already so productive.

The statutes provide that the Commissioners of Inland Fisheries besides introducing, protecting and cultivating fish in the inland waters, shall have a general supervision of all matters relating to trespass upon any waters by fishermen not inhabitants of the State; of the abuses of seining privileges; of the observance of "close time;" and that the annual reports to the General Assembly shall contain such facts and suggestions as the commission may deem proper.

TROUT.

Pursuant with the above-mentioned provisions, the Commissioners during the past year (January, 1897—January, 1898) have purchased twenty thousand (20,000) yearling trout, and acknowledge the generous assistance received in the work of distribution from many fishermen of the State. Most gratifying reports have been received from fishermen during the past open season, and, though there have been a few complaints of illegal fishing, the better class of fishermen are strictly observing the law. The height of water in the streams promises a bountiful catch the coming year.

BLACK BASS.

Black bass fishing has not been satisfactory during the past season, and the Commission feels that its recent efforts and plans for the future in the direction of restocking the inland waters of the State were, and are, fully warranted.

An additional consignment of one thousand large-mouthed black bass has been received from the U. S. Commission, and the same has been deposited in the preserve set apart for the purpose of propagation of this species, near Westerly.

LAND LOCKED SALMON.

Out of three thousand eggs of this species received from the U. S. Commission, in January, the Commissioners have been successful in hatching upwards of two thousand. The young fish were reared until about four inches in length, and then deposited in Mill Brook, in the town of Charlestown. This stream was selected on account of its being the main feeder for Watchaug Lake, and it thus affords a nursery for the young salmon until they are old enough to take care of themselves in the larger body of water. These waters were stocked in May with the eggs of the fresh-water smelt, obtained from New Hampshire, it being necessary to introduce this variety of fish into the lake, as it is the natural food for the land locked salmon. It is the intention of the Commission, pending the result of this experiment, to protect Mill Brook against all fishing. If this experiment is successful, other waters of the State may be similarly stocked.

The Commission again reports that certain sea fishes have been very abundant in Narragansett Bay and its tributaries.

COD.

The cod has been even more plentiful than in 1896, and has often been sold to the consumer for from two to five cents per pound.

MACKEREL.

Small mackerel have been quite plentiful in the upper waters of the bay, having been caught as far up the river as Crescent Park, something heretofore unknown to the oldest fisherman.

TAUTOG.

The early fishing was very good, fish weighing from ten to fifteen pounds being frequently caught.

SCUP.

Large quantities of scup have been caught in the traps in the lower part of the bay, though but few have been taken in the upper waters.

SQUITEAGUE.

The waters of the bay from Field's Point to Newport have abounded with these fish, specimens varying in weight from one to twelve pounds, rod and line fishermen have been afforded rare sport.

We are glad to note a growing interest in the fisheries, an interest that is becoming general all over the world. The progress that has been made in all other departments of industry has not been absent in the fisheries, as the frequent conventions and other means of exchanging information prove. While the sale of salt water fish was formerly restricted to a narrow margin of the coast, the present facilities for packing and transporting enable those engaged in the business to distribute their goods, and markets are to be found in all parts of the country. This great extension of the area of distribution calls for a corresponding increase of supply that at times has taxed the ingenuity and resources of the fisherman to maintain. They have devised, and are using, improved appliances, without which it would be impossible to meet the very large and increasing demand, and there has naturally been some alarm lest the increase of fish caught should exhaust the ocean's supply. Efforts have been made to connect the large catches made by these new appliances with an alleged diminution of the fish, and complaints against the menhaden fishermen seining in the upper waters of the bay have been made to some of the Commissioners by residents along both shores. It is claimed that after the seiners have begun their work food fish are not so plentiful.

While in former reports we have pointed out other probable causes of fluctuation, we wish now to call attention to an additional natural cause that has received little or no attention. Long continued observation and great efforts have been made to learn the history and habits of the ocean fishes. It is known that some spawn in the ocean; others in the shallow salt water; still others in the upper waters of the streams. Now, if there has been a diminution of any of these fish, it is of the fresh water spawners. The kinds that show most notably a decrease are the bass, the shad, and the herring. If we look still further we shall see that the original spawning grounds of these species have been materially affected by the introduction of impurities and by the presence of obstructions. The impurities arise chiefly from the sewage of cities and manufacturer's waste, and will naturally be exceedingly difficult to correct. The obstructions are both artificial and natural. The artificial obstructions, such as dams, etc., may be corrected by the adoption of fishways. The natural obstructions are often of a more serious nature. The sea frequently throws up a bar in estuaries and the mouths of streams in such a way as to prevent the fish from ascending into fresh water and depositing their spawn. Point Judith Pond offers an instance of this kind. The pond and its tributaries comprise the largest enclosed body of water in the State, being about four miles long and one mile and a half wide. In former years large numbers of bass and herring were found in the waters of this pond and in the streams opening into it. It was more than a breeding place, for large numbers of bass were found throughout the winter, though it is possible that they were accidentally shut in by the closing of the "breach." It is fair to infer that under favorable conditions fish would again make this their breeding ground.

Shipment of Fish and Lobsters by regular lines of Transportation from Newport, for the year 1897.

	Fish. Bbls.	Lobsters. Bbls.	Swordfish.
January	270	17	..
February	489	..	..
March	46	1	..
April	204	62	..
May	7,670	225	..
June	6,154	452	..
July	1,610	638	44
August	1,664	380	1
September	3,112	170	..
October	2,557	15	..
November	1,135	19	..
December	147	60	..
	25,058	2,039	45

Total of fish and lobsters, 27,097 barrels.

Table of Shipments by Old Colony Lines.

	Fish. Bbls.	Lobsters. Bbls.	Total.
1886			17,434
1887	16,657	834	17,491
1888	15,033	1,161	16,194
1889	19,306	2,047	21,353
1890	8,933	2,650	11,583
1891	18,032	2,204	20,236
1892	26,832	2,123	28,955
1893	24,452	1,399	25,851
1894	17,769	2,392	21,161
1895	24,622	2,119	26,741
1896	20,425	1,728	22,153
1897	20,900	1,959	22,859

The last year is for ten months, ending November 1st.

The following communication has been received by the Chairman of the Commission:

N. B. CHURCH, Commission Merchant,
Agent for the U. S. Menhaden Oil and Guano Association, No. 153 Maiden Lane.

NEW YORK, January 3, 1898.

J. M. K. SOUTHWICK, Newport, R. I.

Dear Sir:—Replying to your favor of 1st. inst., I desire to say that I would like as usual to send you a full account of our Atlantic Coast fisheries, but fear that I have not kept the matter so fully in mind as usual. The mackerel fisheries began late in March, and was pursued with abundant catches until late in May when the fish disappeared, and were not seen in great quantities for the balance of the season. Shad and all other species of food fish have been very plentiful in their seasons on the whole coast north of Hatteras. Blue-fish, weak-fish, and scup especially so, in fact, so plentiful that it has not paid to catch them.

Menhaden have been very abundant in sections, and the catch runs higher than for several years. Although I have not the full statistics, I think the catch for the entire coast will exceed 600,000,000 fish, or 2,000,000 barrels.

There was a very large body of fish on the coast from Cape Cod to Eastport, Me., and large catches were made by those having factories there. A large body of these fish came into our bays in July and remained about forty days. Good catches were made by those running their factories, but most of the Rhode Island boats were in Maine, where the fish were fatter and more valuable. The Connecticut and New York boats had good fishing in Long Island Sound, Gardner's Bay and along the coast, and made excellent catches. In Delaware Bay, the fishing was as good as could be desired, and large catches were made by all the boats, and the same was true of the Chesapeake Bay and North Carolina coast. About 2,250,000 gallons of oil have been made, with 21,000 tons of dry fish scrap, and 35,000 tons of oiled fish scrap.

Trusting this may help you in making your report, I remain

Very truly yours,

N. B. CHURCH.

SCIENTIFIC WORK.

The past season there was added to this Commission a new member in the person of Professor H. C. Bumpus, and we have begun, under his direction, an investigation of the star-fish, a report of which is submitted herewith. We trust that this new departure in our work will meet with general approval, and be sustained by the State. May we not look forward to no very distant day when we shall have connected with the Commission a laboratory provided with all the necessary apparatus for the study of this and other cognate subjects, that have so important a bearing upon our fisheries?

The Lobster Hatchery, for reasons given in a former report not being in use for its original purpose, was loaned for the investigation of the star-fish, for which it has proved well adapted.

The Chairman, to whom the lobster hatching experiment was intrusted, would respectfully recommend that the property acquired by him for that purpose, together with such sums of money as remain unexpended, be turned over to the Inland Fisheries Commissioners, to be used by them for the purpose of the Commission.

The receipts and disbursements of the Commission have been as follows:

State of Rhode Island in account with Commissioners of Inland Fisheries:

1896.	Dr.	
Dec. 31.	To balance due Commissioners	$203 71
1897.		
Oct. 1.	To paid for 20,000 yearling trout	717 60
Dec. 9.	" " 12 transporting cans	27 00
Dec. 31.	" " expenses, Commissioners	310 07
Dec. 31.	" " printing and postage	21 30
		$1,279 68
1897.	Cr.	
Jan. 29.	By cash of State Treasurer	$203 71
Oct. 5.	" " "	753 12
Dec. 31.	By balance due Commissioners	322 85
		$1,279 68

J. M. K. SOUTHWICK,
HENRY T. ROOT,
CHAS. W. WILLARD,
WM. P. MORTON,
ADELBERT D. ROBERTS,
HERMON C. BUMPUS,

Commissioners of Inland Fisheries.

REPORT OF THE BIOLOGIST

OF THE

COMMISSION OF INLAND FISHERIES.

Many problems of economic interest have been suggested to the members of the Commission as worthy of careful scientific investigation, but one in particular—the depredations of the star-fish—is of such pressing importance that the Commission has recommended its immediate consideration.

Interviews with our fishermen reveal lack of definite information in regard to the habits of the animal, and reference to the literature on the subject yields little of practical value.

The facts before us are as follows:

The natural equilibrium of life in Narragansett Bay has been disturbed; many of the fish which once inhabited our waters have been destroyed; and their place has been taken by new forms; the rivers and streams opening into the bay are now more or less polluted, and are no longer fit breeding places; of recent years the oyster men have cleared and planted large tracts of our shallow inlets, and have thus not only imported millions of oysters but with these, and quite unintentionally, myriads of animals quite new to this locality. In addition to animals quite new to the locality, animals already here have been often emancipated by the destruction of their natural enemies, and have consequently multiplied without restraint. The star-fish belongs to this latter class. It has destroyed many of the large beds of mussels, the attractive feature of our bay for many of the most important food fishes, it has materially assisted in the destruction of the clam, it has reduced the quahaug catch, and would exterminate the oyster were it not for the eternal vigilance of the oyster-men.

In view of the above fact it is remarkable that no one has attempted to determine the methods of life of the star-fish, with the hope of discovering some period of its existence when it can be more easily captured and killed than by the present methods, or of some natural enemy which might destroy the pest without the toil of the fisherman, or of some plan of enclosure which might restrict if not prevent its inroads. A knowledge of the life history of various insects has enabled the agriculturist to prevent their ravages. The understanding of the life habits of bacteria has revolutionized the methods of surgery and medicine. The first step in the campaign against any enemy should be a determination of the characters of the enemy itself.

That this study might be undertaken without delay, my colleagues on the Commission very kindly relinquished a generous part of the appropriation made to them for their expenses, and the Chairman, Hon. J. M. K. Southwick, placed at my disposal the houseboat and car which he had used in connection with his work on the lobster. This floating laboratory was placed at the mouth of the Kickemuit river, immediately over one of the most valuable oyster beds in the bay. It was fully equipped with instruments, microscopes, chemicals, glassware, etc., by the Anatomical Laboratory of Brown University. Dr. A. D. Mead was placed in charge, and certain questions were given him for solution. It will be noted below that many of the questions must, from their nature, remain unanswered until observations have been extended throughout the entire year, and it is probable that two or three years, or even a longer time, will be necessary for the final clearing up of questions of rate of growth, time of sexual maturity, etc. Those who have undertaken similar lines of research know that really valuable results can be secured only through patience and protracted investigation—one well established fact is worth more than a thousand fancies.

The questions are arranged in four groups: the first dealing with the identification and distribution of the star-fish; the second, with the mode of life; the third, with the breeding habits, and the fourth, with natural and artificial means of destruction. The answers, so far as they have been determined, appear in the second part of this report.

INDENTIFICATION AND DISTRIBUTION.

I. Does the animal, known to our fishermen as the star-fish or five-finger, belong to one or several species? (It is evident that, if there are two or more species, artificial or natural agents destructive to one may prove quite harmless to the others.)

II. What is the geographical and bathymetrical distribution? (The reply to these questions will indicate the areas subject to or most liable to invasion.)

MODE OF LIFE.

III. What is the method of locomotion? (It is possible that some barrier might be arranged that would limit, if not prevent, invasion.)

IV. Are the star-fish, which are reputed to appear in schools, in any way different from those known to occur naturally in a particular locality?

V. To or from what distances may star-fish migrate?

VI. What animals are devoured by the star-fish for food? (If the young star-fish feed habitually upon certain animals, it is possible that the destruction of the latter will cause the former to perish.)

VII. What is the method of feeding?

VIII. How rapidly may a star-fish devour oysters?

THE BREEDING HABITS.

IX. At which season of the year do the star-fish spawn? (If at a particular season, a special effort should be made to kill the animals before spawning, and thus destroy both stars and spawn.)

X. What are the habits of the "fry" or free swimming young? (The young of many marine animals, while far more abundant than the adults, are far more delicate and easier of extermination.)

XI. What is the duration of the larval period? (If an effort is to be made to destroy the larvæ, when must it be made?)

XII. What are the habits of the young star-fish? (It is possible that the young star-fish, like the young of many fish, tend to gather in schools. If so, the young might be killed off in thousands.)

XIII. What is the rate of growth up to sexual maturity?

XIV. What is the size and age at sexual maturity?

NATURAL AND ARTIFICIAL MEANS OF DESTRUCTION.

XV. What are the natural enemies of the star-fish?

XVI. Is the popular idea that the dismembered fragments of a star-fish will regenerate new star-fish founded on fact?

XVII. What are the artificial methods of destruction now in use in Rhode Island or elsewhere?

IDENTIFICATION AND DISTRIBUTION.

I. *Does the animal, known to our fishermen as the star-fish or five-finger, belong to one or several species? (It is evident that, if there are two or more species, artificial or natural agents destructive to one may prove quite harmless to the others).*

In a description of the star-fishes of the world W. Percy Sladen recognizes 810 species of these animals, nearly 100 of which are found only in very deep water—below 500 fathoms—and at a depth of even 2,900 fathoms. Several species are found in the waters of Narragansett Bay:—

The common star-fish (Asterias Forbesii).
The purple star-fish (Asterias vulgaris).
The blood star-fish (Cribrella sanguinolenta).
The snake star-fish (Ophiopholis aculeata).

The first species is extremely abundant and is altogether too well known from its depredations on the mussel and oyster beds. The closely related purple star-fish is certainly very rare, at least from Rocky Point north. Among the thousands of stars examined from the oyster beds at Rocky Point, Kickemuit river, and other localities, I have never seen a single specimen. It is, however, common at Newport. If it were as abundant as the common five-finger it doubtless would be equally destructive to the oyster and mussel. The purple star-fish can usually be readily distinguished from the more common species. It has a purple or sometimes reddish color, and a softer, less rigid skeleton, and the arms are more tapering. Other characters, for example the shape of the minute forceps (pedicellaria) which are found among the spines on the whole upper surface of the body, are of more technical value in the determination of species.

The examination of a large number of specimens of the common star-fish, and of the related purple star, shows that there is a great deal of variation among the individuals of the same species with regard to color, shape of the arms, and size and number of spines. These variations are so great that the French naturalist, Perrier, made five distinct species of Asterias to include those star-fish along our coast, which, according to the American naturalists, L. Agassiz, Stimpson, and Verrill, belong to only two species. The fact remains, however, that the star-fish of either species vary greatly in form and color. The young stars whose arms are less than one-half inch in length show the same variation as are seen in the adults. It would be interesting from a biological point of view to determine whether these variarions are due to sex, to surrounding conditions,—food, density of the water, etc.,—or whether they are casual individual differences.

The small blood star-fish, Cribrella, could not easily be mistaken for either of the preceding species. It is bright red, with round, smooth, tapering arms. These stars are found occasionally upon the oyster beds, and several were taken during the dredging excursion from Brown University, in the spring of 1897.

Several specimens of the small snake star-fish, Ophiopholis, were taken at the same time, and it is probable that other species will be discovered.

II. *What is the geographical and bathymetrical distribution? (The reply to these questions will indicate the area subject to or most liable to invasion.)*

In answering this and the following questions reference is made only to the first two species of star-fish, unless otherwise stated.

Geographical distribution. The purple star ranges from Labrador (probably further north) to Cape Hatteras. It is very abundant on the coast of Maine and becomes less common, or even rare, on the southern coast of New England. It is common at Wood's Holl, Mass., but not so abundant as the other species. The common star is distributed from Maine to the Gulf of Mexico. Unlike the purple star it is comparatively rare north of Cape Cod, but is the most abundant species in the southern waters of New England. The two species, therefore, overlap each other in their geographical distribution, though the purple star is the northern, and the common star the southern species.

Bathymetrical distribution. The purple star is found from high water mark to 208 fathoms, while the common star (Asterias Forbesii) has a more limited distribution, viz.: from high water to twenty fathoms. The star-fish of both species often remain among the rocks or in the seaweed after the tide has ebbed.

MODE OF LIFE.

III. *What is the method of locomotion? (It is possible that some barrier might be arranged that would limit, if not prevent, invasion.)*

The furrow on the under side of each arm is furnished with four rows of closely set "suckers" (ambulacral feet). Each of these hollow cylindrical feet can be extended or retracted at will, and is provided with an actual sucker which will hold to almost any surface.

By means of these ambulacral feet the animal walks or crawls. The progress is slow, it is true, but sure, for there is no slipping, and in a few hours a surprisingly long distance can be covered. The feet are so numerous, and the movement so even, that the animal seems rather to glide than to crawl. Moreover the sea-water buoys up the star-fish so that it does not have its weight to support. The star-fish will move easily up the smooth surface of a vertical glass plate or along the underside of a horizontal plane. I have often seen small stars, measuring about three-eighths of an inch from centre to tip of arm, crawl up the side of the aquarium and then glide along the surface of the water. During this performance the star is always on its back, and the suckers extend to the surface of the water.

The buoyancy of the water and the great number of feet enable the animal to move over the lightest silt as well as over hard surfaces. Even large star-fish are able to pass through very narrow and irregular crevices, for the skeleton is composed of innumerable small plates, joined together, and provided with muscles which allows the body to adapt itself to the shape of the crevice. The star-fish, unlike many other marine animals, snails, worms, etc., will never creep out of the sea-water, nor even protrude an arm above the surface. It will never cross a barrier that extends even a little above the surface of the water.

The star-fish is generally believed by fishermen to have a much more active mode of locomotion than that of crawling. The tradition is that large numbers of stars cling together to form a compact ball from a foot to three feet or more in diameter, which is rolled along the bottom by the tide until, striking an oyster bed, the ball goes to pieces and the stars begin work at once. It is difficult to find an actual eye witness of this phenomenon, though Ernest Ingersoll tells of an old oysterman, "Captain Eaton, of New Haven, who said that he and his brother once raked up the end of a cylindrical roll of star-fishes clinging tightly together, which they hauled into their boat until it would contain no more, when they had to break the roll or 'string,' as he called it, which was a foot or more in diameter." The "string" was composed only of star-fishes.

I have never observed anything to confirm in the slightest degree the truth of these stories, though I have seen balls of star-fish clinging to each other. Upon examination it was evident that the stars were all endeavoring to devour some animal held in their midst.

It is difficult to conceive of a barrier which would be practical and efficient in keeping the stars off the oyster bed. The animals can creep over any surface and through small crevices provided they are under water. Theoretically a fine netting across the inlet of an estuary or surrounding the beds, and extending from the surface of high water to the bottom, would keep out the larger stars; or if the oysters were suspended from floats and kept off the bottom the stars could not readily reach them. Neither of these contrivances would, of course, keep off the young stars which for the first two or three weeks of their existence swim about freely in the water.

IV. *Are the star-fish which are reputed to appear in schools in any way different from those known to occur naturally in a particular locality?*

I have thus far not had an opportunity to examine the star-fish reported to appear in schools.

V. *To or from what distance may star-fish migrate?*

I have not yet made experiments to determine.

VI. *What animals are devoured by the star-fish for Food? (If the young star-fish feed habitually upon certain animals, it is possible that the destruction of the latter will cause the former to perish.)*

The young star-fish are exceedingly voracious, perhaps more so than the older ones. They find an abundance of food among the [illegible] of small animals of various kinds which live among rocks covered with sea-weed or in the eel-grass along the muddy shore. In the eel-grass, just below low water mark, the small stars (half-inch more or less from centre to tip) are especially numerous, and here they will be found devouring small clams, quahaugs, sea-snails, and worms of various kinds. The eel-grass is usually abundant near oyster beds and is a veritable nursery for young star-fish. In the aquarium they eagerly devour fragments of crabs or other animals, and occasionally even other star-fish smaller than themselves. The adult star-fish, besides eating numerous small animals which come in its way, attacks and devours larger ones. I have seen them eat the sea-snails Litorina, Ilyanassa, Urosalpinx, barnacles, quahaugs, mussels, as well as oysters. There seems to be no question, however, but that they prefer small oysters to any other diet. If hungry they will also devour other star-fish which are smaller or which have been mutilated.

But we must give the animal his due, and the star-fish should be given the credit of devouring in great numbers, "oyster-drills" of various species, including young "conchs" (Sycotypus and Fulgar), which in southern waters, especially in the Chesapeake Bay and in other countries, for example Japan, where the star-fish are not so common, prove a serious menace to the oyster culture.

VII. *What is the method of feeding?*

The mouth of the star-fish is in the centre of the disc on the lower side of the body. Comparatively small pieces of food are taken into the stomach and the refuse ejected again through the mouth. But, since the mouth is small (no more than one-fourth inch in a good-sized star), and surrounded by a rigid skeleton, larger animals, which form the greater part of the star-fish bill-of-fare, are necessarily digested without being taken in through the mouth. The stomach, therefore, is turned inside out and, wrapping itself about the animal to be devoured, digests gests it where it lies. It is safe to say, I think, that the stomach can be protruded for a distance equal to the length of the star-fish's arm. Having digested the food the stomach is withdrawn to its normal position within the body.

Most of the animals upon which the star-fish prey are molluscs protected by hard shells; for example, the sea-snails, mussels, quahaugs, and oysters. How does the star get at the soft part of the molluscs? This question has given rise to a great deal of interesting, not to say amusing, speculation, especially with respect to the oyster.

An old tradition in England and this country is to the effect that the star-fish takes the oyster by surprise and puts an arm into its gaping shell; then a fight ensues. Sometimes the oyster is victorious while the star-fish retreats minus an arm, but often the oyster succumbs, since it cannot live long with its shell open, and the star then devours its prey at leisure. There are two facts that are sufficient to disprove this theory. In the first place, the oyster is very sensitive and feels the slightest disturbance in the vicinity of the margin of the open shell. In the second place, the shell does not open wide enough to admit the arm of the star. Moreover, simple observation of the star-fish during the process of eating disproves the story.

It is supposed by many that the star-fish secrets a poison into the shell which causes the latter to open. But the valves of the shell can be shut water tight and would exclude such a poison. I have taken away from the star-fish oysters, muscles, and drills which had already been opened, and placed them in an aquarium where they soon recovered and behaved as though nothing had happened. Schiemenz found the same to be true in the case of the quahaug (Venus).

Some have supposed that the star bores a hole through the shell of the victim, but the star has no boring apparatus, and the shells known to be opened by the star have no holes in them.

It is a very common belief that an acid is secreted by the star which dissolves the shell so that an entrance is effected. After a successful opening, however, the litmus-paper shows no acid from the stomach of the star-fish, and the margin of the shells shows no trace of having been acted upon by an acid. A considerable quantity of acid would be required to sufficiently dissolve the shell of a medium sized oyster, and this would undoubtedly dissolve, at the same time, the unprotected calcareous spines about the mouth of the star-fish itself.

The most prevalent opinion is, perhaps, that the star-fish chips away the thin edges of the shell until an entrance is gained to the soft parts. The broken edges of the oyster shells which have been opened by the star seem at first to sustain this opinion. The process is thus described in a recent number of a Providence newspaper. "The star-fish seizes its prey by clasping its tentacles around the soft, fringy edge of the oyster, which it eats away until the soft oyster can be sucked from the orifice, etc." Ingersoll, in an article on Oyster Industry, already referred to, after speaking of the alleged use of acid in opening the shell, says:—"Moreover, it seems unnecessary, since the appearance of every shell attacked at once suggests the breaking down, chipping off movement, which the star-fish might easily produce by seizing and suddenly pulling down with the suckers nearest the mouth, or by a contraction of the elastic opening of the stomach. At any rate the thin edge of the shell is broken away until an entrance is made which the oyster has no way of barricading."

An oyster which has not been injured by rough treatment has the edges of the shell extremely thin and so fragile that they can be broken down with a camel's hair brush. The lower shell is particularly fragile near the edge. It will be noticed, however, that the valves frequently do not come together at all at the extreme edge, and the real line of contact, the biting edge, is one-fourth inch or more further back. The chipping of the margin of the shell by the star-fish is merely accidental, and avails nothing in getting at the soft parts of the oyster. I have carefully examined a large number of shells of oysters known to have been devoured by star-fish, and, though they appear to be badly chipped, the biting edge is never broken, and the shells have always been found to be water tight. If such a shell, recently opened by the star, be filled with water, and the valves held between the thumb and the finger, the water will not leak out even though the shell be violently shaken.

In mussels which have been opened by the star-fish there is no trace of any chipping at all. The reason is plain: the valves of the shell come together firmly at the very edge; there is no delicate fringe at the margin. The same is, of course, true of the quahaug. Nevertheless the quahaug and mussel are readily opened by the star-fish. It follows, therefore, that if the star-fish gained entrance to the soft oyster by chipping off the edge of the shell, a different process must be adopted in entering a mussel or quahaug, to say nothing of the snails which it also devours.

The credit of solving the problem—How do the star-fish open oysters?—is due to Dr. Paulus Schiemenz, of Hanover, Germany, who carried on his investigations at the famous Zoölogical Station at Naples. The problem was suggested to him by Collins' report of the enormous injury done to the oyster beds by the star-fish in Long Island Sound. The process is briefly as follows:—The star-fish so covers his victim that the suckers on the under side of the arms are distributed part to one valve, part to the other, and the remainder frequently to some surrounding object. (In the case of the snails the suckers are attached to the operculum and to the shell). The suckers are very numerous and stick fast, and a tendency to straighten the arms results in a constant pull upon the shells in opposite directions, which, if strong enough, would open the shells. It is true that a star-fish is not strong enough to open an oyster or quahaug immediately in this manner, but he can and does fatigue his prey. The constant, steady pull in opposite directions soon fatigues the muscle which holds the shell together, and the oyster or clam presently gapes open. The oyster can overcome the strong pull for a short time but not a weaker pull for a long time. The same principle is well illustrated in the case of the periwinkle or conch. If a string be tied around the "foot" so as to give a good hold on the animal, a strong man cannot pull the mollusc out of its shell, but if it be suspended by this string it cannot sustain for a long time even its own weight. On the same principle a man who can hold at arm's length a weight of twenty pounds cannot hold his empty hand in this position for ten minutes. Schiemenz showed by experiment that the star could exert a pull of over 1,200 grams, and that a pull of 900 grams is sufficient for opening a good size quahaug if allowed to act for thirty minutes.

My own observations and experiments are entirely in accord with Schiemenz's results.

Frequently more than one star-fish takes part in opening an oyster, and once an oyster is opened other star-fish often happen along and enter into the feast. It is the young oysters that are in greatest danger from the stars, and the danger decreases as the oysters grow larger. Oysters of marketable size, that is, three or four years old, are comparatively unmolested. Of course, the larger star-fish can open the larger oysters, but fortunately the larger stars are more easily caught in the "mops" and thus more easily kept off the beds. It has not been ascertained how large an oyster can be opened by the star-fish.

VIII. *How rapidly may a star-fish devour oysters?*

The answer to this question depends upon several conditions, viz.:—the size of the stars and of the oysters, the temperature of the water, and the hunger of the star-fish. I cannot at present give a very satisfactory answer. Collectively the star-fish devour an enormous number of oysters in a few days. A Providence oysterman informs me that a few years ago, during a few days when his engines were being repaired, so that he could not "mop" the stars, the latter completely destroyed a whole bed (several acres of seed oysters) leaving hardly an oyster alive.

Collins (Notes on the Oyster Fishery of Connecticut) estimates that in 1888 the damage done to the beds in the Connecticut waters alone was $631,500, in spite of the fact that 42,000 bushels of stars were taken from the beds that same year.

IX. *At which season of the year do the star-fish spawn? (If at a particular season, a special effort should be made to kill the animals before spawning, and thus destroy both stars and spawn.)*

The spawning season of the star-fish is undetermined. That they spawn in the summer any oyster-man will tell you. I have found stars containing ripe eggs and ripe spermatozoa from June until December, and should not be surprised if they spawned throughout the year.

X. *What are the habits of the "fry" or free swimming young? (The young of many marine animals, while far more abundant than the adults, are far more delicate and easier of extermination.)*

I have thus far given little attention to the habits of the free-swimming "fry" or brachiolaria. It is well-known, however, that they begin life in the water, that is to say, the female star-fish discharges the eggs unprotected into the water, and the milt or spermatozoa, discharged in the same way by the male, comes in contact with and fertilizes the eggs. In a few hours the eggs have developed into free-swimming forms which propel themselves by means of vibratile hairs definitely arranged on the surface.

Under favorable conditions one can capture millions of these little creatures by dragging a fine net at the surface of the water. They appear and disappear mysteriously however, usually preferring to come to the surface at night. Menhaden and other marine animals, not the least of them the oyster itself, doubtless destroy millions of these minute larvæ.

XI. *What is the duration of the larval period? (If an effort is to be made to destroy the larvæ, when must it be made?)*

The duration of the larval period is about three weeks, but varies according to the temperature of the water, an increase in temperature accelerating development.

XII. *What are the habits of the young star-fish? (It is possible that the young star-fish, like the young of many fish, tend to gather in schools. If so, the young might be killed off in thousands.)*

I have mentioned some of the habits of the young stars under the previous heading. There is little doubt that if the eel-grass were cleared out they would be destroyed in great numbers.

XIII. *What is the rate of growth up to sexual maturity?*

As far as I am aware this is not known. By arranging the star-fish according to size Mr. Agassiz has estimated roughly that it takes about fourteen years to reach full development, but that they may become sexually matured in about six years. I have been unfortunate in losing many of the specimens which I had under observation.

XIV. *What is the size and age at sexual maturity?*

I have made and tabulated some observations to determine the size of the star when it first begins to breed, and believe that it does not reach maturity until it measures two inches from the mouth to tip of arm, and rarely until it is even larger. This conclusion must necessarily be provisional.

XV. *What are the natural enemies of the star-fish?*

Fresh water and extreme cold are most effective in killing off star-fish. Heavy rain storms and freshets so freshen the water in estuaries and shallow bays that great numbers of stars are killed, though the oysters are not harmed. The freshet of March, 1888, practically annihilated the stars on the extensive oyster beds in Kickemuit river, as I am told by the proprietor, and they were not again a serious menace till three or four years later. I have started some experiments to ascertain the least density of water compatible with the life of the star.

The free-swimming "fry" of the star-fish fall prey to many fishes and other animals which feed indiscriminately upon minute pelagic forms. It is not well understood what the enemies of the adult star may be. An oysterman told me that he had seen gulls carrying them off, and with field glasses had watched them. It is possible that crows also prey upon the stars that are left on the beach after the tide has ebbed. The crows in some regions of our coast make daily journeys from their rookeries to the shore, and as many as two hundred and thirty-six were one day counted on the west shore of Portsmouth, R. I.

I have noticed on certain lots of star-fish, dredged from different localities, what appears to be a disease, attacking the skin first and not infrequently eating its way through the body. This disease attacks both the common star and the purple star. Some of the star-fish in my cars at Kickemuit river were so seriously affected that some of the arms were entirely eaten through and the ends dropped off. Later some of them recovered.

The most destructive enemies of many animals are the parasites, and if this disease, to which I have just referred, proves to be due to a bacterium or some other infectious parasite, it may be of service in destroying the star-fish, and thus directly protecting the mussels, clams, and oysters. There seems to be no doubt but that, with the development of the oyster beds, the star-fish has become more numerous along our New England coast.

XVI. *Is the popular idea that the dismembered fragments of a star-fish will regenerate new star-fish, founded on fact?*

It is certainly a most popular opinion that if the star-fish be cut in several pieces each fragment may regenerate the remaining parts so that a new animal results. Ingersoll (Oyster Industry of the United States) says:—"When oysters were first cultivated along the American coast, and this enemy first became known, the oystermen used to save all that they caught in their tongs and dredges, and pile them up in a corner of their boats until evening. Then they would collect them in small packages and draw a cord around each lot tightly enough to cut through it.

This done, the remnants were cast overboard and considered done for. But this was entirely a mistake, as was presently found out. Five or six of these fragments not only retained life but renewed the lost parts and became active again. Thus, instead of diminishing the pest these men were directly increasing it, since they were making two or three star-fishes out of each captive. It was a case of multiplication by division, which may be an invariable paradox in mathematics but is by no means one in zoölogy."

I have made some experiments in order to find out what the actual powers of regeneration are. If the arm of a star be mangled it will generally drop off, or can easily be pulled off, always severing its connection with the central disc at a certain fixed line. If these stars be kept in a suitable car they will renew the lost arms. If an arm be cut off at some distance from the disc it will regenerate a new tip. Double or rather forked arms were produced by cutting off the tip of an arm and splitting the stump. Each half stump, so to speak, regenerated a complete tip. Such freaks are sometimes found among the stars which come up in the dredge or mop.

Four of the five arms were taken off at the same time, and all four regenerated. The arms which were removed, however, never showed the slightest sign of regenerating the rest of the star-fish. Another experiment, I cut the star-fishes into two parts, one having three arms and the greater part of the central disc, the other having two arms and the smaller part of the disc. The smaller part in each case died, while the larger lived. All but one of these specimens were afterwards destroyed by other star-fishes in the aquarium. One still survives and has lived for months in the same aquarium with the stars which have, meantime, regenerated their lost arms. This one, however, has not showed the slightest sign of regenerating its lost parts, nor had the others before they were killed.

More experiments must, of course, be made before a definite conclusion can be reached, but I believe that the popular opinion that two star-fish may be gotten from one, by cutting it up and allowing the fragments to regenerate, is erroneous ; that only one complete star can result from all the fragments, and then only when one fragment contains at least the whole central disc. Complete regeneration from a single arm has been described for certain species by Prof. Haeckel.

XVII. *What are the artificial methods of destruction now in use in Rhode Island or elsewhere?*

Star-fishes are caught in considerable numbers with the spear and tongs, but the more efficient method is the use of the "tangle" or "mop." The tangle consists of a number of mops of cotton waste or similar material attached to an iron bar. By dragging these mops over the oyster beds the stars become entangled and are drawn up with the mops. The mops are usually detached from the iron bar and thrown, together with the stars, into a tub of hot water. Meanwhile other mops are attached to the bar and thrown overboard. After the stars are killed they can be more easily picked off the mops than when they are alive. Some oystermen prefer to dredge up oysters, stars and all, and, having culled out the stars, to replant the oysters. Dead stars make an excellent fertilizer.

APPLICATION FOR APPROPRIATION.

The Commission respectfully asks for an appropriation of $3,000 to defray the expenses of the ensuing year, and bases its application upon the following:

1. The investigation upon the depredations of the star-fish, an account of which accompanies this application, have already yielded sufficient scientific and practical results to warrant their continuation for at least an entire year, that the period of breeding, rate of growth, and seasonal habits may be definitely determined.

2. The reasons for the present depleted conditions of the clam-beds should be known. The breeding habits and breeding period

of the clam should be ascertained, and the feasibility of artificially restocking portions of the shore should be tested. There is here an imperative demand made upon the Commission to rehabilitate a waning industry.

3. The statutes provide that the Commission "shall from time to time examine all the weirs, traps, and other contrivances, with the view of carrying out such regulations as are most beneficial to the people of the State." At the present time the State has no information as to the number, location or ownership of the fish traps, and is keeping no adequate record of the amount of fish caught, or of the amount consumed within the State, or shipped into other States. With the assistance of the fishermen of Rhode Island it has planned to keep a record of the location and ownership of the fish-traps, and to jealously guard our interests against the invasion of those who are not inhabitants of the State.

4. It is the purpose of the Commission to examine into the breeding habits of the food fishes, and to endeavor to induce the shad, and the salmon, to again return to our waters.

5. Your Commissioners are faithfully endeavoring to preserve to the State an industry which has yielded many millions of dollars in the past, and which, if intelligently administered, will continue to be one of its richest possessions. The members of the Commission are serving without salary, and they only ask for sufficient funds to protect and advance the affairs of the fisheries in accordance with the interests and economy of the State.

29,150

State of Rhode Island and Providence Plantations.

TWENTY-NINTH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1899.

PROVIDENCE, R. I.
E. L. FREEMAN & SONS, PRINTERS TO THE STATE.
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COMMISSIONERS OF INLAND FISHERIES OF RHODE ISLAND.

J. M. K. SOUTHWICK, *President*	Newport, R. I.
HENRY T. ROOT, *Treasurer*	Providence, R. I.
WM. P. MORTON, *Secretary*	P. O. Box 966, Providence, R. I.
CHAS. W. WILLARD	Westerly, R. I.
ADELBERT D. ROBERTS	P. O. Box 264, Woonsocket, R. I.
HERMON C. BUMPUS, Ph. D.	Brown University.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, its January Session, 1899:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1898:

The appropriation, which was made by your honorable body, has enabled the Commissioners of Inland Fisheries to arrange their affairs in a much more satisfactory manner than heretofore, and to accomplish far more for the fishery industries of the State than during any previous year.

The problems undertaken by the Commission have been as follows:

First. The stocking of our ponds and streams with suitable fresh-water fish, through the distribution of eggs and fry.

Second. The collection of definite data respecting the times of arrival and departure of various food fish, and the preparation of statistics of exportation.

Third. The determination of the breeding periods of native marine animals.

Fourth. The location of fish traps and other appliances for the capture of fish.

Fifth. The physical and biological examination of the waters of the bay, and the preparation of a record of the present physical and biological conditions.

Sixth. The investigation of the plague which destroyed multitudes of fish and crustacea during the fall of 1898.

Seventh. The continuation of the observations begun in 1897 on the life-habits of the starfish.

Eighth. A survey of the waters of the bay and of the waters immediately off shore, for the purpose of determining the distribution of the starfish.

Ninth. A study of the life-habits of the clam, and an investigation of the present depleted conditions of the clam beds.

Tenth. The preparation of a relief map of Narragansett Bay.

Eleventh. An examination into the feasibility and practicability of artificial lobster culture.

Twelfth. The extension of the commercial fisheries of the State, through the discovery of new localities for food fish.

Thirteenth. Improvements in the methods of preparing fish for shipment.

How successful the Commission have been in the prosecution of their work will appear in the sequel under appropriate captions.

The receipts and disbursements of the Commission have been as follows:

State of Rhode Island in Account with Commissioners of Inland Fisheries.

1897.	DR.	
Dec. 31.	To balance due Commissioners	$322 85
1898.		
Sept. 26.	To paid for 20,000 yearling trout	678 80
Dec. 31.	" " investigating star-fish, flat-fish, clam, and lobster	1,583 11
	" " expenses of Commissioners	635 35
	" " skiff	20 00
	" " printing, advertising, postage	34 72
		$3,274 83
1898.	CR.	
Jan. 6.	By cash of State Treasurer	$322 85
April 2.	"	613 58
July 14.	"	15 55
31.	"	26 33
31.	"	100 00
Aug. 31.	"	164 89
31.	"	72 55

1898.			
Aug. 31.	By cash of State Treasurer	22	34
31.	"	464	94
Sept. 26.	"	600	00
Oct. 31.	"	212	22
Dec. 28.	"	69	92
31.	"	123	65
31.	"	50	00
31.	"	47	99
31.	"	28	62
31.	"	24	00
31.	"	266	10
31.	"	11	80
	Balance due Commissioners	37	50
		$3,274	83

J. M. K. SOUTHWICK,
HENRY T. ROOT,
CHAS. W. WILLARD,
WM. P. MORTON,
ADELBERT S. ROBERTS,
HERMON C. BUMPUS,

Commissioners of Inland Fisheries.

I. *The Stocking of our Ponds and Streams with Suitable Fresh-Water Fish, Through the Distribution of Eggs and Fry.*

During the past year the Commissioners have purchased twenty thousand yearling trout, and with the generous assistance of many fishermen have distributed them in various portions of the State.

BLACK BASS.

Large- and small-mouthed black bass have been placed in various ponds and rivers during the past season. Some very good catches of large fish have been reported. The United States Commission has kindly contributed five hundred large-mouthed black bass, which have been placed in the preserve set apart for the purpose of propagating this species, near Westerly.

LAND-LOCKED SALMON.

Three thousand fry were liberated in Mill Brook, May 9, 1898.

II. *The Collection of Definite Data Respecting the Times of Arrival and Departure of Various Food Fish, and the Preparation of Statistics of Exportation.*

For this purpose blank forms were distributed to the shore fishermen early in the summer, and the data thus obtained will be of practical assistance in the future work of the Commission.

An examination of the following table will show a most gratifying increase in the shipments by freight and express from Newport. Large quantities of fish are carried directly to the New York markets by those owning the larger "off-shore" traps, and many fish are also sent to New York and other market centres from Wickford and East Greenwich.

Shipment of Fish and Lobsters by Regular Lines of Freight Transportation from Newport, for the Years 1897 and 1898.

	1897.	1898.	1897.	1898.	1897.	1898.
	Fish.		Lobsters.		Swordfish.	
	Bbls.		Bbls.		Number.	
January	270	518	17	11	..	..
February	489	509	..	..	..	..
March	46	112	1	1	..	..
April	204	475	62	38	..	..
May	7,670	11,583	225	219	..	..
June	6,154	8,668	452	212	..	..
July	1,610	3,144	638	432	44	14
August	1,664	3,378	380	218	1	7
September	3,112	2,351	170	25	..	1
October	2,557	2,441	15	4	..	..
November	1,135	648	19	5	..	52
December	147	235	60	13	..	..
Total	25,058	34,065	2,039	1,163	45	74

Total of fish and lobsters, 1897; 27,097 barrels.

Total of fish and lobsters, 1898; 35,228 barrels.

To the above shipments by freight may be added the following:

	Fish.	Lobsters.	
Shipments from Newport by express	4,229	2,560	
Total shipment	38,294	3,723	— 42,017 bbls.

The following is a tabulated statement of the relative quantities of fish shipped by *freight* from Newport over the Old Colony lines for the past thirteen years. It will be noticed that the shipment for 1898 is considerably greater than for any previous year, and is more than 50 per cent. greater than for 1897.

Table of Shipments by Old Colony Lines.

	Fish. Bbls.	Lobsters. Bbls.	Total.
1886			17,434
1887	16,657	834	17,491
1888	15,033	1,161	16,194
1889	19,306	2,047	21,353
1890	8,933	2,650	11,583
1891	18,032	2,204	20,236
1892	26,832	2,123	28,955
1893	24,452	1,399	25,851
1894	17,769	2,392	21,161
1895	24,622	2,119	26,741
1896	20,425	1,728	22,153
1897	20,900	1,959	22,859
1898	34,065	1,163	35,228

Fresh fish have been shipped direct from Newport to the following cities:

Albany, N. Y.,
Amsterdam, N. Y.,
Boston, Mass.,
Brockton, Mass.,
Buffalo, N. Y.,
Chicago, Ill.,
Dayton, Ohio,
Detroit, Mich.,
Dighton, Mass.,
Fall River, Mass.,
Ft. Edward, N. Y.,
Grand Rapids, Mich.,
Ithaca, N. Y.,
Jamestown, N. Y.,
Kansas City, Mo.,
Middletown, N. Y.,
New York, N. Y.,
Newburg, N. Y.,
New Bedford, Mass.,
Olean, N. Y.,
Poughkeepsie, N. Y.,
Providence, R. I.,
Riverside, R. I.,
Rome, N. Y.,
St. Louis, Mo.,
Saratoga, N. Y.,
Schenectady, N. Y.,
Tiverton, R. I.,
Troy, N. Y.,
Taunton, Mass.,
Warren, R. I.

III. *The Determination of the Breeding Periods of Native Marine Animals.*

Inasmuch as the movements of fish are largely controlled by the food supply, and the food supply is the direct consequent of the reproductive activity of the lower animals, it is essential that the Commission should have data relative to the breeding habits of both fish and the lower marine animals. The data collected during the past year has been published in "Science," where it is available for reference, and hence it seems unnecessary to publish it again in this report.

IV. *The Location of Fish Traps and Other Instruments for the Capture of Fish.*

The statutes of Rhode Island provide that the Commission "shall from time to time examine all the weirs, traps, and other contrivances, with the view of carrying out such regulations as are most beneficial to the people of the State." At the beginning of the present year the State had no information as to the number, location, or ownership of fish traps, and was consequently unadvised respecting the extent to which market fishing was carried on within its borders. Assisted by the boats of the United States Fish Commission and of the Marine Biological Laboratory, the Commissioners have visited all the fish traps, and while they have found the number to be large (115), they have found them controlled by an exceptionally intelligent class of men, well informed respecting the movements of marketable fish. The equipment and maintenance of these appliances represents the investment of considerable capital and the employment of a large number of men. A large proportion of the fish captured are consumed beyond the limits of the State, and the list of cities (section II) to which shipments are directly made indicates very clearly the reputation which the State must enjoy as a fisheries centre. It is unnecessary to argue that large sums of money are brought into the State through the activities of those immediately interested in this industry.

Although the Commission is not in possession of facts respecting the influence which the great sea traps, temporarily located in the deeper water off the mouth of the bay, may have upon the fishes within the limits of the bay, it is almost the universal opinion among those who are handling large quantities of fish that the capture during the past year has been of much more than average value. This is the more interesting since serious complaints of damage wrought to the industry by wholesale methods of capture have been infrequent. Although the "twine" destroys thousands of barrels of fish which never even reach the market, and extensive "pounding" leads to the destruction of enormous numbers of enclosed fish, there is, at the present time, no other adequate way of capturing and of retaining certain fish until the market is in such a condition as to make their sale profitable. There is no question but that the sea traps are so efficient as instruments of capture that they frequently defeat their own purposes through capturing such enormous quantities of fish that the market becomes overstocked. During the past season, as heretofore, fish from these outside traps have not only been shipped from Newport over the regular lines of transportation, but some of the larger concerns have combined and carried their own fish to New York.

Scup are the principal fish captured off shore, and often the nets contain practically nothing else. Inasmuch as scup is one of the most popular food fish, and since it appears quite impossible for it to find a market when most abundant, it would seem that some plan of canning the scup would develop an industry, in the southern portion of the State, which might yield considerable revenue. It will be the purpose of the Commission the coming year to examine into the practicability and feasibility of preserving these fish.

The traps within the bay are often set as early as March, when alewives, or buckies, are captured. Mr. Lewis, on the 17th of last March, caught seventeen hundred. During the early spring flat-fish are abundantly taken. The spring squeteague arrive about the first of June, when they are small but are said to bear spawn. The regular run of squeteague extends over about four weeks, from early in June to early in July. The fish have been very abundant during the past season, fifty barrels often being taken from a single trap at one haul. Sometimes the squeteague are so eager in their pursuit for young herring that they swarm into the shallow water in almost countless numbers, when they may be picked up with the hand and thrown upon the beach. Mr. Lewis tells me that he saw such a school last summer near Sanderstown, and that he waded into the water and captured sixty-three fish. The squeteague of late years has become a very popular food and game fish, and, although it does not endure protracted icing, an increasing number are finding their way to the larger centres of consumption. It appears on the bills of fare of many resorts as "blue-fish," and, although inferior in keeping qualities and in flavor, its abundance has given it a place among the marketable food-fish which the more or less uncertain blue-fish does not enjoy. The fishermen, moreover, look with increasing favor upon the arrival of the squeteague, for when it comes it comes to stay, and it does not drive away other fish. Scup may be taken in the traps, even at the head of the bay, Bristol, and East Greenwich. On the 3d of July seventy-five barrels were turned out of traps, near Wickford, as valueless. The tautog is taken in the traps in the spring and fall, although during the summer it is generally caught with hook and line.

A year ago the cod was so abundant in the traps around Sakonnet, Newport, and Point Judith that the nets became seriously damaged, and the market became overstocked. Some idea of their abundance may be gathered from the statement that on one day four men in a catboat caught eleven hundred and seventy. During the past fall the cod has not been sufficiently abundant to ruin its market.

In the spring of 1898 (April and May) many small cod, weighing about three pounds, were caught in the traps near Wickford. The appearance of these young cod, in considerable numbers and in localities where they have been heretofore unknown, is generally explained by the fishermen as an immediate result of the methods of artificial propagation which have been carried on at the Woods Hole Station. The millions of cod fry that have been liberated near our shore must have materially affected the fish fauna. Mr. F. H. Hoar caught near Bristol a large "racer cod" weighing about five pounds. Old fishermen in this portion of the bay consider this capture noteworthy, since they do not remember of ever having caught cod in this locality. It would seem possible that with increased facilities for artificial propagation even the upper waters of the bay may yield an abundance of what are ordinarily considered to be deep-water food-fish.

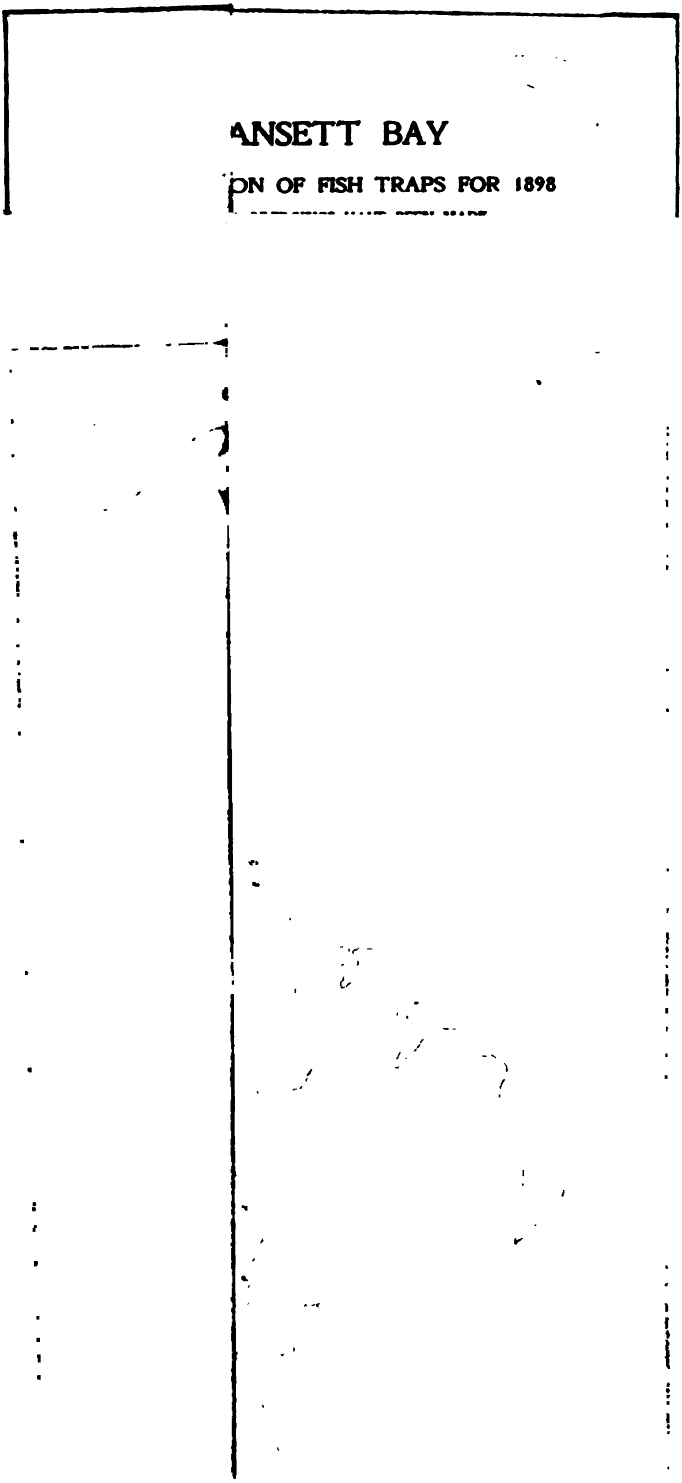
A list of the principal owners of fish traps is herewith given, together with the localities in which the traps are set:

Almy, Frank K.	Sakonnet River.
Brownell, Gilbert	" "
Cattle, Wm.	Tiverton.
Cattle, Wm.	"
Church, J. B.	Sakonnet Point.
Church, Daniel	" "
Church, Daniel	" "
Cory & Martin	" River.
Cory & Martin	" "
Cory, Edw. J.	" "
Cory, Edw. J.	" "
Cottrell, Samuel	Popasquash.
Cottrell, Samuel	Popasquash.
Cottrell, Samuel	Mt. Hope.
Cottrell, Samuel	Bristol.

Doan, S. P	Rumstick.
Durfee, Thomas	Tiverton.
Durfee, Thomas	“
Durfee, Thomas	Hog Island.
Fish, Clinton	Tiverton.
Gray, Geo. E	Sakonnet River.
Gray, Geo. E	Cory's Wharf, Sakonnet River.
Grinnell, Philip	Sakonnet River.
Grinnell, Philip	“ “
Harvey, Wm	“ “
Helger, Henry	Prudence.
Helger, Henry	“
Hoar, Fred H	Bristol.
Negus, Jos	Tiverton.
Rice, Herbert	Potowomut.
Rice, Herbert	“
Riley, Tom	Tiverton.
Seabury, Ben	Sakonnet River.
Shepard, John	Bristol.
Shepard, John	Popasquash.
Simons, John M	Tiverton.
Simons, Wm	Sakonnet River.
Spink, J. W	Prudence.
Taber, Alonzo	Tiverton.
Wilcox, Henry	Sakonnet River.
Wilcox, J. S	Tiverton.
Wilcox Bros. (Ralph and Holder)	Sakonnet River.
Wilcox Bros. “ “	“ “
Wilcox Bros. “ “	“ “
Wilson, A. A	Prudenee.
Wilson & Mitchell	Potowomut.

Calvert, Geo	Coggeshall's Ledge.
Carpenter Bros	South Ferry, Watson's Pier.
Carpenter, Geo	Beaver Head.

Easterbrooks, Comer	Price's Neck.
Gladding, A. B.	Castle Hill.
Gladding, A. B	Coddington Cove.
Gladding, A. B	Coddington Cove.
Goddard, Al	Brenton's Point.
Harvey, Charles	West Shore.
Hicks, O. G	Brenton's Point.
Lake, Isaac	Conanicut.
Lawton, Ned	Brenton's Cove.
Lawton, Ned	Mackerel Cove.
Lawton, W. H	Mackerel Cove.
Lewis, J. O. & G. A	Quonset Point.
Lewis, J. O. & G. A	Quonset Point.
Lewis, J. O. & G. A	Wild Goose Point.
Lewis Bros., W. A., F. A., T. W	Plum Beach.
Lewis Bros	Casey's Point.
Lewis, J. O. & G. A	Conanicut.
Lewis Bros	Conanicut.
Lewis Bros	Conanicut.
Manchester, Daniel	Quonset Point.
Manchester, Daniel	Quonset Point.
Mitchell, Gordon	Conanicut.
Northrup Bros	Beaver Tail.
Peckham Bros	Sachuest Point.
Rose, W. R	Coggeshall's Ledge.
Rose, W. R	Conrad's Cove.
Spink, J. W	Conanicut.
Spink, J. W	Conanicut.
Spink, J. W	Beaver Head.
Tourjee, Stephen	Beaver Tail.
Tourjee, Stephen	Beaver Head.
Tourjee, Stephen	Sanderstown.
Two, Jean	Sachuest Point.
Wadsworth, Leman	Roane's Point.



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Sea Traps.

Brightman, W. J	Coggeshall's Ledge.
Brightman, W. J	Seal Rock.
Brightman, W. J	Off Cormorant Rock.
Brownell, J. M	Seal Rock.
Church, J. B	Coggeshall's Ledge.
Cottrell, Geo. F	Off Cormorant Rock.
Church, J. B	Off Cormorant Rock.
Cottrell, Geo. F	Off Seal Rock.
Gladding, A. B	Coggeshall's Ledge.
Lewis, Frank	Seal Rock.
Macomber, Frank	Off Cormorant Rock.
Rose, G. O	Coggeshall's Ledge.
Rose, W. R	Seal Rock.
Rose, W. H	Off Cormorant Rock.
Thompson, Noah	Off Seal Rock.

In the above list the sea traps are located as off Seal Rock, Coggeshall's Ledge, Cormorant Rock. They are arranged in three long series, extending as will be seen by reference to the chart accompanying this report.

V. *The Physical and Biological Examination of the Waters of the Bay.*

A physical examination of the shore waters of the State has been made for the purpose of establishing a standard, variations from which, from time to time, will be recorded. The Commission regrets that such physical examination as it thus far has been enabled to make covers only a portion of the year, for the measurements of the salinity of water, to be of permanent value, should include the entire twelve months. When observations of density are taken for only a limited time it is quite possible that, as a result of prevailing wind or excessive rain-fall, the data secured is extreme, and consequently not representative of the average conditions. The limited resources of the Commission, however, have prevented them from giving the attention to this subject which it really deserves.

Four hundred and eighty-four specific gravity and temperature observations have been taken.

In perfectly pure fresh water the salinometer reading is 1.000; but as the water becomes hard, through the addition of salts, the readings of the salinometer increase, and in the open ocean, near Block Island, the heaviest water taken had a specific weight of 1.025; and at no locality south of the line drawn from Beaver Tail to Sakonnet was it of less density than 1.023. As we ascend the Bay the water becomes less and less salt, and readings as low as 1.020 were taken near Allen's Harbor, to the westward of Prudence Island, and near Bristol Ferry. The salinity of the water in the Providence river was considerably less, being 1.017 near Sassafras Point; although the surface water was only 1.008. As has already been stated, the record of a single series of specific gravity observations, in itself, is of no moment; but inasmuch as it is the purpose of the Commission to add extensively to the data during the coming year, this permanent record will prove of considerable value inasmuch as the salinity of the water bears upon the question of successful oyster culture.

Although, as is well known, fresh water is fatal to the oyster, and prolonged immersion in the water, even as fresh as 1.007, will very materially affect the marketable qualities of the animal, successful oyster culture cannot be carried on in water that is, for any considerable period, lighter than 1.011 or heavier than 1.022. Between these limits there are still large tracts of available ground in the upper portion of the bay which are still unoccupied by oyster culturists, and there are also a great many localities farther down the bay, near the openings of fresh water streams, where, with proper protection and freedom from the invasion of the starfish, oysters of fine quality may be raised.

The following section on biological conditions prevailing in the waters of the Bay and on the bottom, although technical, is of importance, since the life in the water is the expression of the water's purity, average salinity, and average temperature. If the water in any portion of the bay becomes contaminated the life upon the bottom is immediately affected, and this is shown either by the migration of animals from the infected locality, or, in a case of animals unable to move about rapidly, by their death. Many of the animals found on or immediately below the surface of the mud bear shells which exist for many years after their soft parts have perished. It is possible, then, for one acquainted with the facies of the shore fauna, to state what the probable biological conditions have been. The animals which are found in colder water off shore are strikingly different from those found in the warm waters of the bay, as is beautifully illustrated by the distribution of the several species of starfish. Your Commission, therefore, has felt justified in recording, at considerable length, the physical and faunistic conditions in the different portions of the bay, and feels confident, in so doing, that they will materially assist in the work of future years.

Even in such a filthy portion of the Providence River as lies north of Field's Point, there is still a remarkably rich assemblage of life. This is in direct contradiction of what might have been predicted, and is sufficient ground for the belief that, with the expenditure of a little care in the disposal of sewerage and manufacturers' waste, important food fish might actually be caught from our wharves in sufficient numbers to be of economic importance. In this tract of the river two species of shrimp (*Crangon Palæmonetes*) abound; *Squilla*, or mantis shrimp, are repeatedly taken. *Platyonichus*, *Panopeus*, *Callinectes*, and *Libinia* represent the more common species of crabs, while a small hermit (*Eupagurus*) is taken at nearly every cast of the dredge. The following molluscs and vertebrates were taken: *Ilyanassa*, *Venus*, *Mulinea*, *Sycotypus*, *Mytilus*, *Tritia*, *Mya*, skate (*Ria*), flat-fish (*Pseudopleuronectes*), and a pipe-fish (*Siphostoma*). Starfish of small size also grow in this locality. Farther down the river, between Rocky Point and Rumstick, the water becomes relatively clean, and several additional forms are found. Stars have become large and very abundant. All of the crustacea and molluscs above mentioned are found in increased numbers, and to these may be added *Pelia*, *Cancer*, *Yoldia*, *Clidiophora*, and *Eupleura*. The further distribution of animals can be more readily understood by confining our attention to the stations at which observations were made by the "Fish Hawk."

Record of Dredging *by U.S. Fish Commission Steamer "Fish Hawk," Lt.-Com'd'r Richard G. Davenport, U.S. Navy, commanding.*

(In service of U. S. Fish Commission).

Station.	Date, 1898.	Depth.	Bottom.	Instrument.	Air.	Temperature.		Density.		Contents.
						Surface.	Bottom.	Surface	Bottom.	
1	Oct. 26.	33 ft........	Sand, shell	Dredge	62° F.	15.0° C.	61.0° F. 14.5° C	1.022	1.022	Nothing in dredge.
2	Oct. 28.	22½ ft.......	Black mud	7 ft. trawl......	51° F.	12.5° C.	13.0° C.	1.017	1.019	Squilla, Crangon, Palæmonetes, Ilyanassa, Tritia (dead), Mya (dead).
3	Oct. 28.	22½ ft.......	Black mud	7 ft. trawl......	51° F.	13.0° C.	13.5° C.	1.011	1.017	Platyonichus, Crangon, Eupagurus, Venus, Mulinea, Ilyanassa.
4	Oct. 28.	27 ft........	Black mud	7 ft. trawl......	52° F.	13.0° C.	14.0° C.	1.007	1.017	Common Star, Crangon, Panopeus, Balanus, Mulinea, Ilyanassa, Sycotypus, Mytilus, Hydroids, Raja, Pseudopleuronectes, Syphostoma.
5	Oct. 28.	28½ ft.......	Black mud	7 ft. trawl......	58° F.	13.0° C.	13.0° C.	1.008	1.018	Squilla, Crangon, Balanus, Eupagurus, Mulinea, Ilyanassa, Pseudopleuronectes, Rhynchobolus.
6	Oct. 28.	22½ ft.......	Black mud	7 ft. trawl......	54° F.	13.5° C.	14.0° C.	1.007	1.017	Common Star, Callinectes, Libinia, Mulinea, Tritia, Mya.
7	Oct. 28.	31½ ft.......	Black mud	7 ft. trawl......	56° F.	14.0° C.	14.0° C.	1.008	1.018	Platyonichus, Crangon, Mulinea, Crepidula, Hydroids.
8	Oct. 28.	4—6 fath...	Mud..................	7 ft. trawl......	57° F.	13.5° C.	13.0° C.	1.020	1.020	Large Common Stars, Squilla, Callinectes, Pelia, Eupagurus, Panopeus, Palæmonetes, Yoldia, Clidiophora, Tritia, Ilyanassa, Mulinea, Raja, Bothus.
9	Oct. 28.	3½—4½ fath.	Mud..................	7 ft. trawl......	50° F	13.5° C.	13.0° C.	1.019	1.020	Common Star, Cancer, Crangon, Eupleura, Mulinea, Tritia, Yoldia, Clidiophora, Cistenides.
10	Oct. 31.	15 fath.....	Mud and sand.........	7 ft. trawl......	57° F.	12.6° C.	13.0° C.	1.022	1.024	Nothing in trawl.
11	Oct. 31.	12 fath.....	Sand..................	10 ft. trawl	53° F.	12.7° C.	13.4° C.	1.022	1.024	Maroon Stars, Eupagurus, Crangon, Tritia, Raja, Hake.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE	BOTTOM.	SURFACE.	BOTTOM.	
12	Oct. 31.	12 fath.....	Sand..................	10 ft. trawl....	53° F.	13.0° C.	13.6° C.	1.022	1.023	Common Stars, Purple Stars, Cancer, Callinectes, Gammarus, Limulus, Tritia, Hydroids, Astyris, Nudibranch, several fish.
13	Oct. 31.	11 fath.....	Sticky..................	10 ft. trawl....	56° F.	13.0° C.	13.0° C.	1.022	1.024	Purple Stars, Maroon Stars, Cancer, Caprella, Gammarus, Eupagurus, Nucula, Tritia, several fish.
14	Oct. 31.	19½ fath....	Sticky..................	10 ft. trawl....	55° F.	13.1° C.	13.8° C.	1.022	1.0235	Maroon Stars, Pandalus, several fish.
15	Oct. 31.	13¾ fath....	Hard sand............	10 ft. trawl....	54° F.	13.0° C.	13.5° C.	1.022	1.0235	Cribrella, Cancer, Pandalus, Pecten, Modiola, several fish.
16	Oct. 31.	15 fath.....	Hard..................	10 ft. trawl....	54° F.	13.0° C.	13.1° C.	1.022	1.024	Purple Stars, Eupagurus, Pinnotheres, Pandalus, Pecten (tenu-icostatus), Buccinum, Hydroids, several fish.
17	Nov. 1.	9½ fath.....	Rocks and sand.......	10 ft. trawl....	56° F.	12.8° C.	13.0° C.	1.023	1.024	Purple Stars, Hydroids, Urosalpinx, Astyris, Anomia, Saxicava, Lepidonotus, Cliona.
18	Nov. 1.	13 fath.....	Rocks and sand.......	7 ft. bm. trawl.	58° F.	12.9° C.	13.1° C.	1.023	1.024	Maroon Stars, Cribrella, Eupagurus, Crangon, Tritia, Crepidula, Cliona.
19	Nov. 1.	13 fath.....	Rocks and sand.......	7 ft. bm. trawl.	52° F.	13.0° C.	13.5° C.	1.023	1.024	Small Purple Stars, Cribrella, Eupagurus, Urosalpinx, Tritia, Corbula, Mytilus, Anachis, Cliona, Astrangia, Ophiopholis, Amarœcium.
20	Nov. 1.	22½ fath....	Sticky, rough..........	Small dredge..	52° F.	13.7° C.	13.8° C.	1.023	1.024	No Starfish. Unciola, Small Amphipods, Neptunea, Yoldia, Tritia, Small Holothurians, Clidiophora (alive), Cyprina, Astarte, Cardium (dead), Sternaspis. Specimens from this station not all identified.
21	Nov. 1.	22 fath.....	Sandy..................	7 ft. bm. trawl.	55° F.	13.0° C.	13.0° C.	1.023	1.024	Purple Stars, Maroon Stars, Cribrella, Crangon, Pandalus, Eupagurus, Cancer, Caprella, Unciola, Isopods, Tritia, Neptunea, Pecten, Lucina (dead), Ilyanassa, Suberites, several fish.

RECORD OF DREDGING.—*Continued.*

Station.	Date. 1898.	Depth.	Bottom.	Instrument.	Air.	Temperature.		Density.		Contents.
						Surface.	Bottom	Surface.	Bottom.	
22	Nov. 1.	22 fath.....	Hard sandy............	7 ft. bm. trawl.	54° F.	13.1° C.	13.2° C.	1.023	1.023	Purple Stars, Maroon Stars, Pandalus, Eupagurus, Crangon, Cancer, Pecten, Crepidula, Buccinum, Cyprina (dead), Neptunea (dead), Hydroids, several fish, Squid.
23	Nov. 1.	20 fath.....	Hard sand.............	7 ft. bm. trawl.	53° F.	13.1° C.	12.7° C.	1.023	1.0235	Maroon Stars, Purple Stars, Cribrella, Green Urchins, Holothurians, Eupagurus, Pandalus, Cancer. Crangon, Pecten, Crucibulum, Squid, Hydroids, Alcyonium, several fish.
24	Nov. 1.	16 fath.....	Hard sand.............	7 ft. bm. trawl.	51° F.	13.0° C.	12.9° C.	1.023	1.023	Maroon Stars, Purple Stars, Cribrella, Echinarachnius, Holothurians, Pandalus, Eupagurus, Cancer, Squid, Mactra, Astarte, Pecten, Cyclocardia, Anachis, Hydroids, several fish.
25	Nov. 1.	13 fath.....	Hard gravelly.........	7 ft. bm. trawl.	50° F.	13.0° C.	12.7° C.	1.023	1.025	Purple Stars, Holothurians, Echinarachnius, Pandalus, Caprella, Crangon, Eupagurus, Cancer, Mactra, Astarte, Tritia, Lunatia, Sponge, Hydroids, Bugula, several fish.
26	Nov. 2.	7½ fath.....	Mussel bed	7 ft. bm. trawl.	56° F.	12.7° C.	13.0° C.	1.022	1.026	Common Stars, Cribrella, Brittle Star, Arbacia, Panopeus, Pinnotheres, Eupagurus, Mytilus, Crepidula, Urosalpinx, Pennaria, Hydractinia, Trophonia, Lepidonotus, Bugula, several fish, shells.
27	Nov. 2.	10½ fath....	Stony, shelly..........	7 ft. bm. trawl.	56° F.	12.5° C.	13.0° C.	1.022	1.022	Common Stars, Heteromysis, Panopeus, Crangon, Eupagurus, Crepidula, Urosalpinx, Tritia, Serpula, Lepidonotus, Bryozoa, Hydroids, Microciona, shells.
28	Nov. 2.	9 fath......	Hard sandy............	7 ft. bm. trawl.	56° F.	12.3° C.	13.0° C.	1.021	1.022	Common Stars, Cribrella, Panopeus, Amphipods, Lepidonotus, Cliona, Escharella, shells.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
29	Nov. 2.	7 fath......	Sandy......	7 ft. bm. trawl.	57° F.	12.3° C.	12.7° C.	1.021	1.023	Common Star, Crangon, Amphipods, Panopeus, Eupagurus, Crepidula, Tritia, Serpula, Lepidonotus, Cliona, Hydroids, few fish.
30	Nov. 2.	5 fath......	Sticky mud...........	7 ft. bm. trawl.	57° F.	12.2° C.	13.0° C.	1.021	1.022	Common Star, Crangon, Pelia, Eupagurus, Teredo, Nucula, Mulinea, Clidiophora, Eupleura, Argina, Lyonsia, Serpula, Cistenides, Botryllus, Metridium, several fish, shells.
31	Nov. 2.	5 fath......	Muddy................	7 ft. bm. trawl.	56° F.	12.1° C	12.7° C.	1.020	1.025	Common Star, Eupagurus, Pelia, Cancer, Crangon, Yoldia, Clidiophora, Crepidula, Nucula, several fish, shells.
32	Nov. 2.	5 fath......	Muddy, shelly.........	7 ft. bm. trawl.	56° F.	12.2° C.	12.6° C.	1.021	1.024	Common Star, Squilla, Panopeus, Pinnixa, Crangon, Pelia, Yoldia, Clidiophora, Eupleura, Mulinea, Annelids, Cliona, several fish, shells.
33	Nov. 2.	4½ fath.....	Muddy................	7 ft. bm. trawl.	56° F.	12.0° C.	12.5° C.	1.021	1.025	Common Stars, Cancer, Squilla, Crangon, Sycotypus, Clidiophora, Yoldia, Anomia, Tritia, several fish, shells.
34	Nov. 2.	4½ fath.....	Muddy................	7 ft. bm. trawl.	56° F.	12.1° C.	12.6° C.	1.021	1.022	Common Stars, Squilla, Crangon, Panopeus, Crepidula, Eupleura, Callista, Mulinea, Yoldia, Serpula, Cliona, several fish, shells.
35	Nov. 2.	8 fath......	Muddy................	7 ft. bm. trawl.	56° F.	13.0° C.	13.2° C.	1.021	1.023	Common Stars, Crangon, Eupagurus, Cancer, Yoldia, Pecten, Astarte, Annelids, Hydractinia, Tubularia, several fish, shells.
36	Nov. 2.	7 fath......	Muddy................	7 ft. bm. trawl.	56° F.	12.7° C.	13.0° C.	1.021	1.023	Common Stars, Green Urchin, Eupagurus, Astarte, Clidiophora, Cyclocardia, Pecten, Thracia, Littorina, Tritia, Yoldia, Trophonia, several fish, shells.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
37	Nov. 3.	18 fath.....	Hard, rock and sand..	7 ft. bm. trawl.	52° F.	13.4° C.	13.6° C.	1.023	1.023	Common Stars, Purple Stars, Cribrella, Eupagurus, Tritia, Bugula, Bryozoa, Alcyonium, Cliona, Amarœcium, several fish.
38	Nov. 3.	19 fath.....	Hard sandy...........	7 ft. bm. trawl	52° F.	13.6° C.	14.1° C.	1.023	1.023	Common Stars, Purple Stars, Maroon Stars, Brittle Stars, Pandalus, Eupagurus, Cancer, Squid, Tritia, Lunatia, Cyprina (dead), Lepidonotus, Pennaria, several fish.
39	Nov. 3.	20 fath.....	Hard sandy...........	7 ft. bm. trawl.	53° F.	13.5° C.	13.5° C.	1.023	1.023	Common Stars, Maroon Stars, Purple Stars, Holothurians, Green Urchins, Eupagurus, Pandalus, Isopods, Cancer, Squid, Crepidula, Cyclocardia, Lucina (dead), Tritia, Spirorbis, Bryozoa, several fish.
40	Nov. 3.	18 fath.....	Sand..................	7 ft. bm. trawl.	53° F.	12.8° C.	13.2° C.	1.023	1.024	Purple Stars, Maroon Stars, Brittle Stars, Arbacia, Cancer, Caprella, Pandalus, Eupagurus, Isopod, Pycnogonid, Squid, Pecten, Modiola, Buccinum, Crucibulum (dead), Chiton, Hydroids, shells, several fish.
41	Nov. 3.	7½ fath.....	Gravelly..............	7 ft. bm. trawl.	54° F.	13.2° C.	13.0° C.	1.023	1.023	Purple Stars, Brittle Star, Cribrella, Isopods, Amphipods, Crangon, Cancer, Squid, Nudibranch, Anachis, Astyris, Tritia, Pennaria, Astrangia, Spirorbis, Sponge.
42	Nov. 3.	20½ fath....	Sand, gravelly.........	7 ft. bm. trawl.	57° F.	13.3° C.	13.2° C.	1.023	1.023	Maroon Stars, Purple Stars, Pandalus, Eupagurus, Pecten, Crucibulum, Cyclocardia, Neptunea, Squid, Crepidula, Tubularia, Alcyonium, Anemone, several fish.
43	Nov. 3.	20 fath.....	Sandy, gravelly.......	7 ft. bm. trawl.	57° F.	13.1° C.	13.2° C.	1.023	1.023+	Maroon Stars, Echinarachnius, Pandalus, Eupagurus, Cancer, Crangon, Pecten, Tritia, Astarte, Neptunea, Coral, Alcyonium, several fish.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
44	Nov. 3.	16 fath.....	Hard sand............	7 ft. bm. trawl.	56° F.	13.3° C.	13.7° C.	1.023	1.023+	Maroon Stars, Echinarachnius, Pandalus, Eupagurus, Crucibulum, Squid, Pecten, Tritia, Lunatia, Crepidula, several fish.
45	Nov. 3.	17½ fath....	Sandy.................	7 ft. bm. trawl.	56° F.	13.0° C.	13.2° C.	1.023+	1.024	Maroon Stars, Echinarachnius, Pandalus, Eupagurus, Squid, Lunatia, Tritia, Buccinum, Suberites, several fish.
46	Nov. 4.	18 fath.....	Sandy, shelly..........	7 ft. bm. trawl.	58° F.	13.3° C.	14.0° C.	1.023	1.023+	Maroon Stars, Echinarachnius, Pandalus, Eupagurus, Crangon, Crucibulum, Crepidula, Buccinum, Squid, Tritia, Neptunea, Cyprina (dead), Hydractinia, Tubularia, Suberites, several fish.
47	Nov. 4.	14 fath.....	Sandy.................	7 ft. bm. trawl.	59° F.	13.3° C.	13.3° C.	1.023	1.024	Maroon Stars, Echinarachnius, Pandalus, Cancer, Crangon, Crepidula, Tritia, Buccinum, Spirorbis, several fish.
48	Nov. 4.	9½ fath.....	Sand, gravel..........	7 ft. bm. trawl.	57° F.	13.0° C.	12.5° C.	1.023	1.023	Common Stars, Maroon Stars, Echinarachnius, Eupagurus, Libinia, Crangon, Pelia, Buccinum, Urosalpinx, Lunatia, Tritia, Chalina, several fish.
49	Nov. 4.	5 fath......	Gravelly..............	7 ft. bm. trawl.	60° F.	12.0° C.	12.1° C.	1.022+	1.023	Maroon Stars, Crangon, Eupagurus, Balanus, Crepidula, Littorina, Tritia, Hydractinia, Ciona, Chalina, several fish.
50	Nov. 4.	4½ fath.....	Rocky.................	7 ft. bm. trawl.	60° F.	12.0° C.	12.4° C.	1.022	1.023	Common Star, Balanus, Eupagurus, Pelia, Libinia, Crepidula, Urosalpinx, Neverita, Argina, Scapharca, Lunatia, Serpula, Lepidonotus, Eupleura (dead), Membranipora, Escharella, Hydractinia, several fish.
51	Nov. 4.	5½ fath.....	Rocky, gravelly.......	7 ft. bm. trawl.	61° F.	11.8° C.	12.2° C.	1.022	1.022	No Stars. Pelia, Callinectes, Cancer, Libinia, Eupagurus, Panopeus, Anomia, Cerithiopsis, Scapharca, Balanus, Lepidonotus, Bryozoa, Hydroids, Hydractinia, Microciona, several fish, shells.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
52	Nov. 4.	4 fath......	Rocky, gravelly........	7 ft. bm. trawl.	61° F.	11.5° C.	12.0° C.	1.022	1.023	Common Stars, Argina, Crangon, Cancer, Balanus, Pelia, Eupagurus, Libinia, Anomia, Mulinia, Crepidula, Hydroids, Hydractinia, Microciona, several fish, shells.
53	Nov. 4.	7 fath......	Mussel bed............	7 ft. bm. trawl.	56° F.	13..° C.	13.8° C.	1.021+	1.022+	Common Stars, Arbacia, Cancer, Panopeus, Pinnotheres, Callinectes, Mytilus, Lepidonotus, several fish, shells.
54	Nov. 4.	7½ fath.....	Rocky..................	7 ft. bm. trawl.	56° F.	12.8° C.	13.7° C.	1.021+	1.022	Common Stars, Purple Stars, Strongylocentrotus, Cancer, Idotea, Eupagurus, Gammarus, Panopeus, Squid, Mytilus, Crepidula, Buccinum, Spirorbis, Lepidonotus, Bryozoa, Laminaria, several fish, shells.
55	Nov. 4.	9½ fath.....	Sandy..................	7 ft. bm. trawl.	56° F.	13.6° C.	14.0° C.	1.022	1.023	No Stars. Pelia, Cancer, Eupagurus, Crangon, Gammarus, Mytilus, Sycotypus, Lunatia, Tritia, Nudibranch, Mactra, Laminaria, shells bored by drill, several fish.
56	Nov. 4.	14½ fath....	Rocky, sandy..........	7 ft. bm. trawl.	53° F.	13.0° C.	13.3° C.	1.022	1.022	Common Stars, Maroon Stars, Purple Stars, Pandalus, Cancer, Callista, Cyclocardia, Lunatia, Anomia, Cyprina (dead), Tritia, several fish.
57	Nov. 4.	17½ fath....	Rocky, sandy..........	7 ft. bm. trawl.	51° F.	12.5° C.	13.0° C.	1.021+	1.023	Common Stars, Purple Stars, Maroon Stars, Pandalus, Libinia, Eupagurus, Astarte, several fish, shells.
58	Nov. 9.	4½ fath.....	Muddy	7 ft. bm. trawl.	58° F.	11.3° C.	12.7° C.	1.019	1.022+	Twenty-four Common Stars, 2½—6 inches across.
59	Nov. 9.	4½ fath.....	Muddy, with gravel...	7 ft. bm. trawl.	60° F.	11.5° C.	12.5° C.	1.019	1.021	One hundred Common Stars, 2½-6 inches across.
60	Nov. 9.	6½ fath.....	Mussel bed............	7 ft. bm. trawl.	62° F.	12.0° C.	13.0° C.	1.019	1.020+	Over one hundred Common Stars, nearly all large size, 6—8 inches across; a few 3—4 inches across.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
61	Nov. 9.	15 fath.....	Hard	7 ft. bm. trawl.	62° F.	11.9° C.	13.6° C.	1.021	1.021	Five Common Stars, 1—3½ inches across; one Brittle Star, one Red Star (*Cribrella*).
62	Nov. 9.	15 fath.....	Shelly	7 ft. bm. trawl.	60° F.	12.0° C.	14.1° C.	1.020	1.021+	Nearly eighteen hundred Common Stars, 4—6 inches across, some larger; one dozen Red Stars (*Cribrella*), different sizes.
63	Nov. 12	8½ fath.....	Rocky.	Dredge	38° F.	11.4° C.	10.8° C.	1.023+	1.023	(Rocky bottom; dredge torn off and lost).
64	Nov. 12	11 fath. ...	Rocky and sandy......	Dredge	38° F.	12.8° C.	12.0° C.	1.023	1.023	No Stars.
65	Nov. 12	9½ fath.....	Rocky and sandy......	Dredge	38° F.	11.3° C.	12.0° C.	1.023	1.023+	No Common Stars. Eight Purple Stars, 1—1½ inches across; a number of small Red Stars (*Cribrella*).
66	Nov. 12	11½ fath....	Rocky.	Dredge	38° F.	11.9° C.	11.2° C.	1.023	1.023	No Stars.
67	Nov. 12	7 fath......	Rocky.	7 ft. bm. trawl.	39° F.	10.8° C.	11.0° C.	1.023	1.023+	No Stars.
68	Nov. 12	6 fath......	Rocky.	7 ft. bm. trawl.	40° F.	11.0° C.	11.3° C.	1.023	1.023+	No Common Stars. A few small Red Stars (*Cribrella*).
69	Nov. 12	5 fath......	Hard	Dredge	44° F.	10.8° C.	11.0° C.	1.023	1.023	No Stars.
70	Nov. 12	6¼ fath.....	Hard	Dredge	44° F.	10.8° C.	11.0° C.	1.023	1.023	No Stars.
71	Nov. 12	8¼ fath.....	Sand and shell	Dredge	44° F.	11.7° C.	12.0° C.	1.023	1.023+	No Stars.
72	Nov. 12	7½ fath.....	Fine gravel and shell..	Dredge	44° F.	11.8° C.	11.4° C.	1.023	1.023	No Common Stars. Two small Purple Stars; a few small Red Stars (*Cribrella*).
73	Nov. 12	5¼ fath.....	Sandy and rocky......	7 ft. bm. trawl.	44° F.	11.5° C.	11.1° C.	1.023	1.023+	No Stars.
74	Nov. 12	8¾ fath.....	Hard	7 ft. bm. trawl.	45° F.	11.8° C.	11.7° C.	1.023	1.023	No Stars.
75	Nov. 12	8½ fath.....	Hard	7 ft. bm. trawl.	45° F.	11.8° C.	11.4° C.	1.023	1.023	No Stars.
76	Nov. 14	$\frac{7}{10}$ fath....	Rocky, and mussel bed	7 ft. bm. trawl.	52° F.	11.0° C.	11.2° C.	1.022	1.022+	Fifty-four Common Stars, 3—7 inches across, mostly large; one very small Star.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
77	Nov. 14	9½ fath.....	Mussel bed, muddy....	7 ft. bm. trawl.	52° F.	10.8° C.	11.0° C.	1.022	1.022+	About two hundred Common Stars, very numerous and large; one Red Star (*Cribrella*).
78	Nov. 14	7½ fath.....	Rocky...........	7 ft. bm. trawl.	52° F.	10.6° C.	10.8° C.	1.0216	1.022	Two dozen Common Stars, 1½—4 inches across.
79	Nov. 14	6 fath......	Rocky and shelly......	7 ft. bm. trawl.	51° F.	10.4° C.	10.5° C.	1.022	1.022	One small Common Star, regenerating.
80	Nov. 14	5 fath......	Mussel bed, rocky.....	7 ft. bm. trawl.	52° F.	10.5° C.	10.7° C.	1.021	1.021+	Fourteen Common Stars, 1—3 inches across.
81	Nov. 14	4 fath......	Muddy................	7 ft. bm. trawl.	52° F.	10.2° C.	10.7° C.	1.021	1.021+	Nearly one hundred Common Stars, 1—5 inches across.
82	Nov. 14	3¾ fath.....	Muddy................	7 ft. bm. trawl.	52° F.	10.0° C.	10.1° C.	1.020	1.021	One hundred and twenty small Common Stars, 1—3 inches across.
83	Nov. 14	4¾ fath.....	Muddy, shelly.........	7 ft. bm. trawl.	52° F.	10.1° C.	10.0° C.	1.020+	1.022+	About one hundred and seventy-five Common Stars, 1½—4 inches across.
84	Nov. 14	4½ fath.....	Muddy, shelly.........	7 ft. bm. trawl.	52° F.	10.0° C.	10.0° C.	1.020	1.021	About one hundred and fifty Common Stars, 1½—4 inches across.
85	Nov. 14	4½ fath.....	Shelly, muddy.........	7 ft. bm. trawl.	52° F.	10.0° C.	9.8° C.	1.020	1.020+	Over eighty Common Stars, 1—4 inches across.
86	Nov. 14	12½ fath....	Hard	7 ft. bm. trawl.	48° F.	11.0° C.	10.8° C.	1.022	1.022	Two dozen Common Stars, 1—4 inches across.
87	Nov. 14	24 fath.....	Hard	7 ft. bm. trawl.	48° F.	11.0° C.	10.7° C.	1.021+	1.022+	Over two dozen Common Stars.
88	Nov. 14	19 fath.....	Hard	7 ft. bm. trawl.	46° F.	10.3° C.	10.6° C.	1.021	1.021+	No Common Stars. One Red Star (*Cribrella*); a few small Serpent Stars.
89	Nov. 15	8 fath......	Very rocky............	Dredge........	40° F.	12.7° C.	11.3° C.	1.023+	1.024+	No Stars. (Dredge torn to pieces.)
90	Nov. 15	14 fath.....	Fine gravel and sand.	Dredge........	40° F.	12.0° C.	11.3° C.	1.023+	1.024	No Stars.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE.	BOTTOM.	
91	Nov. 15	12 fath.	Hard gravelly	Dredge	40° F.	12.0° C.	11.4° C.	1.023+	1.023+	No Common Stars. Red Star (*Cribrella*) small and plentiful.
92	Nov. 15	15½ fath.	Hard	Dredge	41° F.	11.4° C.	11.2° C.	1.023+	1.023+	No Stars.
93	Nov. 15	6¼ fath.	Sandy, hard	Dredge	42° F.	11.2° C.	11.5° C.	1.023	1.023	No Common Stars. One small Purple Star, ¼ inch across.
94	Nov. 15	7¾ fath.	Hard, shelly	Dredge	42° F.	11.3° C.	11.5° C.	1.023	1.023	No Stars.
95	Nov. 15	10 fath.	Hard, shelly	Dredge	44° F.	11.2° C.	11.8° C.	1.023	1.023+	No Common Stars. One small Maroon Star, 3 inches across.
96	Nov. 15	7¾ fath.	Hard	7 ft. bm. trawl.	43° F.	11.2° C.	11.8° C.	1.023+	1.023+	No Stars.
97	Nov. 15	10 fath.	Hard	7 ft. bm. trawl.	44° F.	11.3° C.	12.1° C.	1.023+	1.023+	No Stars.
98	Nov. 15	10 fath.	Hard	7 ft. bm. trawl.	44° F.	11.6° C.	12.8° C.	1.023	1.023	No Stars.
99	Nov. 15	10½ fath.	Hard	7 ft. bm. trawl.	44° F.	11.6° C.	12.5° C.	1.023	1.023	One Common Star, 5 inches across.
100	Nov. 15	6½ fath.	Hard	7 ft. bm. trawl.	45° F.	11.5° C.	12.0° C.	1.023	1.023	No Stars.
101	Nov. 15	6½ fath.	Hard, rocky	7 ft. bm. trawl.	46° F.	11.5° C.	12.0° C.	1.023	1.023	No Common Stars. A number of small Red Stars (*Cribrella*).
102	Nov. 15	11 fath.	Very rocky	7 ft. bm. trawl.	46° F.	12.0° C.	12.1° C.	1.023	1.023	No Common Stars. Several small Red Stars (*Cribrella*); a few Serpent Stars.
103	Nov. 15	9 fath.	Very rocky	7 ft. bm. trawl.	46° F.	11.5° C.	12.0° C.	1.023	1.023	No Common Stars. A few small Red Stars (*Cribrella*).
104	Nov. 15	6¾ fath.	Very rocky	7 ft. bm. trawl.	48° F.	11.2° C.	11.8° C.	1.023	1.023	No Common Stars. A few small Red Stars (*Cribrella*).
105	Nov. 15	5 fath.	Stony	Dredge	49° F.	11.0° C.	11.1° C.	1.023	1.023	Two small Common Stars, 1 inch across; three Purple Stars, 1—2½ inches across; a few Red Stars (*Cribrella*).

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE	BOTTOM.	SURFACE.	BOTTOM.	
106	Nov. 15	6¼ fath.....	Gravelly, sandy.......	Dredge........	47° F.	11.0° C.	10.8° C.	1.023	1.023	No Common Stars. Four small Purple Stars, 1—2⅛ inches across; a few Red Stars (*Cribrella*).
107	Nov. 15	7 fath......	Sandy, gravelly........	Dredge........	48° F.	11.0° C.	10.4° C.	1.023	1.023	No Stars.
108	Nov. 15	5¾ fath.....	Gravel, sand..........	Dredge........	47° F.	10.8° C.	10.1° C.	1.023	1.023	Eight Common Stars. ⅛—2⅛ inches across; a few Red Stars (*Cribrella*).
109	Nov. 15	5¾ fath.....	Gravel, sand..........	10 ft. bm. trawl	47° F.	10.7° C.	10.8° C.	1.023	1.023	Five Common Stars, 1—2 inches across; two Purple Stars; a few Red Stars (*Cribrella*).
110	Nov. 15	5 fath......	Rocky.................	10 ft. bm. trawl	47° F.	11.0° C.	10.9° C.	1.023	1.023	One Common Star, one inch across; five Purple Stars, 1—2¼ inches across.
111	Nov. 16	10—20 fath.	Hard..................	7 ft. bm. trawl.	51° F.	12.2° C.	12.0° C.	1.022+	1.023	No Common Stars. Ten Maroon Stars, 2—4 inches across.
112	Nov. 16	26 fath.....	Hard, smooth..........	7 ft. bm. trawl.	48° F.	11.2° C.	11.0° C.	1.022+	1.023+	No Common Stars. Several small Purple Stars, 1⅛—4 inches across; a few Red Stars (*Cribrella*); one Serpent Star.
113	Nov. 16	23 fath.....	Smooth, hard..........	7 ft. bm. trawl.	58° F.	11.0° C.	12.2° C.	1.022	1.023	No Common Stars. Two Purple Stars, 1⅛—2 inches across; a few Red Stars (*Cribrella*); one Serpent Star.
114	Nov. 16	9¾ fath.....	Muddy, shelly.........	7 ft. bm. trawl.	54° F.	10.8° C.	11.0° C.	1.021+	1.023	Over one hundred Common Stars, medium size.
115	Nov. 16	15 fath.....	Muddy, shelly.........	7 ft. bm. trawl.	58° F.	10.1° C.	10.5° C.	1.021	1.022+	Half-bushel Common Stars, 1—5 inches across.
116	Nov. 16	18 fath.....	Clayey................	7 ft. bm. trawl.	58° F.	10.1° C.	11.0° C.	1.020	1.022	Common Stars; one Serpent Star.
117	Nov. 16	18½ fath....	Soft, part hard........	7 ft. bm. trawl.	50° F.	10.2° C.	11.0° C.	1.020	1.022+	One hundred and twenty-five Common Stars.
118	Nov. 16	15 fath.....	Muddy, shelly.........	7 ft. bm. trawl.	50° F.	9.8° C.	11.8° C.	1.020	1.021+	About seventy-five small Common Stars.

RECORD OF DREDGING.—*Continued.*

STATION.	DATE, 1898.	DEPTH.	BOTTOM.	INSTRUMENT.	AIR.	TEMPERATURE.		DENSITY.		CONTENTS.
						SURFACE.	BOTTOM.	SURFACE	BOTTOM.	
119	Nov. 16	11 fath.....	Muddy, shelly.........	7 ft. bm. trawl.	50° F.	9.8° C.	10.7° C.	1.020	1.023	About one hundred Common Stars, 1—6 inches across, mostly small.
120	Nov. 16	3½ fath.....	Soft mud.............	7 ft. bm. trawl.	49° F.	9.8° C.	10.2° C.	1.020	1.021	Three Common Stars, 1¼—4 inches across.
121	Nov. 16	4 fath......	Muddy................	7 ft. bm. trawl.	49° F.	10.2° C.	11.0° C.	1.020	1.021	About fifty small Common Stars, 1½—4 inches across.

The following stations, 17—25, 37—43, 107—110, in Block Island Sound, could not be shown on the chart. They are located as follows:

17. Point Judith Light, N. ¼ E., 1¾ miles.
18. Point Judith Lighthouse, N.E. × E., 2.7 miles Mag.
19. Point Judith Lighthouse, N. × E. ½ E., 3¼ miles Mag.
20. Point Judith Light, N.E. ½ N., 4.7 miles Mag.
21. Block Island North Light, W. × S. ½ S., 3¾ miles Mag.
22. Block Island North Light, W. × N. ½ N., 4⅜ miles Mag.
23. Block Island South-east Light, S.W. ¾ W., 2¾ miles Mag.
24. Block Island South-east Lighthouse, N.W., 1.62 miles Mag.
25. Block Island South-east Lighthouse, N.E. ¼ E., 2.75 miles Mag.
37. Block Island North Light, S. ¼ E., 2.50 miles Mag.
38. Block Island North Light, E. × S., 1.75 miles Mag.
39. Block Island North Light, N.E. × E, 3.25 miles Mag.
40. Block Island North Light, N.E. ½ E., 4.50 miles Mag.
41. Block Island South-east Light, E. ¼ N., 3.50 miles Mag.
42. Block Island North-east Light, E. × N., 6 miles Mag.
43. Point Judith Light, N.W. ½ N., 7.25 miles Mag.
107. Point Judith Light, E. ½ S., 2.25 miles Mag.
108. Point Judith Light, W. × N. ¾ N., 3 miles Mag.
109. Point Judith Light, E. × S., 3.75 miles Mag.
110. Point Judith Light, E. ¾ S., 4.50 miles Mag.

VI. *The Investigation of the Plague which Destroyed Multitudes of Fish and Crustacea During the Fall of 1898.*

BY A. D. MEAD.

During the last two months the inhabitants of Rhode Island witnessed the following remarkable phenomenon. The water of a considerable portion of the bay became thick and red, emitting an odor almost intolerable to those living near by. The situation became alarming when, on the 9th and 10th of September, thousands of dead fish, crabs, and shrimps were found strewn along the shores or even piled up in windrows.

At the request of the Rhode Island Commission of Inland Fisheries, an investigation was made to determine the cause and extent of the unusual color of the water, and of the great mortality of the fish. The results of this investigation are briefly as follows:

During the last of August, throughout September and a part of October, streaks of red or "chocolate" water were observed from near Quonset Point and Prudence Island, north to Providence, and, on the flood tide, up the Seekonk river, nearly to Pawtucket, a range of about fifteen miles. In other parts of the bay, as far as could be learned, the phenomenon had not been observed.

On the 8th and 9th of September the water became extremely red and thick in various localities from East Greenwich to Providence, and the peculiar behavior of the marine animals attracted much attention. Myriads of shrimps and blue crabs, and vast numbers of eels, menhaden, tautog, and flat-fish came up to the surface and to the edge of the shore as though struggling to get out of the noxious water. Indeed, the shrimp and crabs were observed actually to climb out of the water upon stakes and buoys, and even upon the iron cylinders which support one of the bridges and which must have been very hot in the bright sun. In several instances, on these two days, hundreds of blue crabs were caught by a single individual in a few minutes' time, at the mouth of the Seekonk.

On the following day, September 10th, and for several days afterwards, hardly a live crab or shrimp could be found. Along the shores, however, in the same vicinity, cartloads of dead shrimp were piled up in windrows, and among them were strewn great numbers of crabs and fish of various kinds, especially menhaden and eels. This singular behavior and alarming mortality of marine animals was reported from nearly every station at which the red water occurred, and from no other station, which indicates that the two phenomena are related as cause and effect.

It was commonly believed that dye-stuffs or other refuse emptied into the rivers at the upper part of the bay gave to the water its color and unpleasant odor, but microscopic examination showed that the water was swarming with minute organisms, species of *Peridinium*. The *Peridinium* is reddish brown in color and occurred in such excessive abundance that it gave to the water its peculiar color and odor, besides making it so opaque that one could hardly see a white shell six inches below the surface.

With regard to the systematic position of this organism there is a difference of opinion. It is, in fact, ranked with the animals by some authors, and with the plants by others. I have not yet been able to determine the species of our *Peridinium*. It resembles in many respects Carter's *Peridinium sanguineum;* it is much flattened, and the anterior end is distinctly bilobed, like *Peridinium tabulatum*, though the lobes are more rounded. Besides a flagellum extending forward from the ventral groove, a very large flagellum lies in the equatorial sulcus and entirely encircles the body. No cilia could be demonstrated.

After September 9th and 10th, when the great mortality of fish occurred, the *Peridinium* became, for a few days, less abundant, and then increased again until the 23d. There was a heavy rain on the 23d, and on the following day the water was comparatively clear. Since this date it has been more or less in evidence up to the day of writing (October 7th). On September 21st the number of *Peridinium* per cubic centimeter in the Seekonk river was estimated at 5,880. This was enough to give the water a very noticeable red color. Nevertheless, the marine animals appear not to have been seriously affected since September 10th or 11th, though the approach of a streak of red water has, in some instances, interrupted good fishing.

In the Seekonk River the shrimp and crabs gradually returned, and in about three weeks after the sudden mortality were nearly as numerous as before, though the water was at times distinctly colored. On the 23d some shrimp, oysters, and small fish (*Fundulus*) were kept in the water where the *Peridinium* were the thickest, and suffered no apparent injury. In consideration of these facts, it has been doubted whether the *Peridinium* was the immediate cause of the peculiar behavior and death of the fish which occurred on the 9th and 10th of September, especially as the weather had been phenomenally hot for several weeks previous to those dates. I believe, however, that the *Peridinium* was the cause of the trouble, and not the hot weather or manufacturers' waste, for the following reasons:

On the two or three days in which the mortality took place the water was extremely red.

The hot weather was followed by a cold wave a day or two before the mortality commenced.

The phenomena occurred in Greenwich Bay and off Nayatt, many miles from any considerable source of contamination.

Finally, the phenomena in question were noticed by very many persons throughout the whole range of the red water, while in neighboring portions of the bay, for example, in the Warren River and in Bristol harbor, where the temperature of the water is quite as high as in the red-water districts, no *Peridinium* and no mortality or unusual behavior of the marine animals was reported, though the regions were carefully canvassed.

There are many recorded instances of salt and of fresh water colored red probably by *Peridinium* of this or a similar species. H. J. Carter, in his account of "The Red Coloring Matter of the Sea round the Shores of the Island of Bombay," described the new species *P. sanguineum*, which produces this effect. He points out, also, that Darwin's description of the animalcule which he found to color the sea red, a degree south of Valparaiso, accords exactly with that of *Peridinium*. The animalcules which, according to Salt, produce the red color in the Red Sea, may be this form, and the same cause may perhaps be ascribed to the red color of the sea off Iceland in 1649. Carter quotes the following passage from an eye witness of a similar occurrence at Porebunder, on the coast of Khattywar, India, where the red water is extremely common: "The color of the sea water on Saturday evening last, the 27th of October, 1849, was changed from its usual tint to a deep red, emitting a most foul smell; the fish speedily were all destroyed and washed upon the beach in large quantities, etc." Though the narrator believed that this might be due to a submarine eruption of mud, Mr. Carter is inclined to ascribe it to some "animalcule," most probably *Peridinium*. He also directs attention to the Mosaic account of the plague of Egypt given in the following verses: "And all the waters that *were* in the river were turned to blood." "And the fish that *was* in the river died; and the river stank; and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt."

VII. *The continuation of the observations begun in 1897 on the life habits of the starfish*—and

VIII. *A survey of the waters of the Bay and of the waters immediately off shore, for the purpose of determining the distribution of the starfish.*

Early in the investigation of the starfish problem it became evident that the starfish are not evenly distributed throughout the Bay, but that there were certain centres of distribution from which they migrated, often in great numbers, to adjoining mussel and oyster beds, and where during the breeding season they carried on the process of reproduction with great activity. The question naturally arose:—If the starfish in these areas of distribution and centres of reproduction could be exterminated, would they be eliminated permanently, or only temporarily owing to constantly recurring invasion from the outside waters through the channels of the Sakonnet River and the East and West Passages? In other words, is the present excessive abundance of the starfish due to propagation within the waters of the Bay, or is it the result of migration from extra-territorial areas? If the former, efforts toward the annihilation of the pest would probably prove successful; if the latter, such efforts, except on a grand scale, would prove futile.

The Commission was materially aided in prospecting this line of work by the United States Commission of Fish and Fisheries, who generously detailed the steamer "Fish Hawk", amply equipped with scientific apparatus, and manned by an able body of men specially trained for this line of work.

The results of this investigation are most satisfactory, since they prove that the stars, so immediately damaging to the oyster, clam, and scallop industries, and, through the rapidity with which they devour the mussels, indirectly damaging to the general fisheries of the State, are actually the result of home breeding, and are probably never materially re-inforced through migration of the adults from outlying waters. Indeed, it is probable that even the larvæ are not brought into the Bay by the currents in such numbers as to materially affect the local biological conditions.

There are, besides the "red star" (Cribrella) and the "snake star" (Ophiopholis), three different varieties of starfish common to our coast. Of these, the first, or common star, is known to the fishermen as the "five-finger." The second is of more delicate texture, soft, and of a rich orange or maroon color. The third is of a purplish color. Of these varieties the first is the only one of economic interest at the present time, and the investigations have shown that, while it occurs in vast swarms within the waters of the Bay, it is only occasionally found in the heavier waters of the ocean. On the other hand, the "maroon stars" are frequently found off Brenton's Reef, along the shore line near Point Judith, and around Block Island. With the "maroon stars" are the still less abundant purple stars. The area of distribution of the common stars is thus seen to be practically limited by a line drawn across the narrow portion of the mouth of the East and West Passages and the Sakonnet River. Above this line neither "purple" nor "maroon stars" occur, and below this line common "five-fingers" are very infrequent, and even when found are generally of small size. Whether the latter owe their distribution to the direct influence of the salinity of the water, temperature, nature of ocean bottom, depth, or food, we are unable to say, although it seems probable, from such observations as we have made, that the animals flourish in warmer and brackish water of moderate depth; this, however, may result from the fact that the stars find in this environment their most abundant food supply.

In certain localities, and particularly over mussel beds, the starfish are so numerous that they actually form a covering over the sea bottom. Mr. Gardiner has informed us that near the old Nayatt Light he has taken twelve hundred bushels of stars from four acres of sea bottom, an average of three hundred bushels to the acre. The average potato crop is 91.8 bushels per acre.* There is a long mussel bed lying in the west channel, and since, as Dr.Mead has shown, the reproductive energy of the star is directly dependent upon the food supply, there are places over this mussel bed where the starfish become gigantic in size, and where there are enough eggs extruded during the breeding period to keep the entire Bay stocked with the pest.

The Commission has located the enemy, tested its strength, is acquainted with its habits, and purposes to begin a war of extermination. Its first method will be to hire the necessary boats and go directly to the localities where the enemy is intrenched, dredge the stars from the bottom, and thus destroy the breeders. The Commission has consulted many of the leading oystermen, and is convinced that this method of procedure is practicable, and that the money expended will be many times returned in the increased receipts from the rental of land suitable for oyster culture.

The following is the special report of the investigations of Dr. A. D. Mead, made under the direction of the Commission.

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* In Rhode Island, 1880-1889.

SPECIAL REPORT ON THE STARFISH.

BY A. D. MEAD.

The investigation of the habits and life-history of the starfish has been continued during the past year, along the lines originally laid down by the Commission, and published in the last *Report*. The observations were made principally at the Kickemuit river, where the house-boat, moored over one of the oyster beds, served as a floating laboratory. Through the courtesy of the United States Fish Commission, in extending to me the privilege of the Woods Holl Station, and in giving me the use of one of the steam launches, I was able to make some observations upon the starfish of Buzzards Bay, and of other portions of Narragansett Bay. From the oystermen I have received valuable information and assistance, and on every occasion the kindest treatment.

The problems with regard to the starfish, which were originally suggested to me for solution, and which formed the basis of my report for 1897, are given below in full, together with the additional information which I have been able to obtain since writing the last report. Occasionally, when the context requires it, a brief abstract is given from the former report.

IDENTIFICATION AND DISTRIBUTION.

I. *Does the animal, known to our fishermen as the starfish, or five-finger, belong to one or to several species? (It is evident that, if there are two or more species, artificial or natural agents destructive to one may prove quite harmless to the others.)*

We have in Narragansett Bay four species of starfishes, out of the eight hundred or more which are known to occur the world over. They are:

The common starfish (Asterias Forbesii).
The purple starfish (Asterias vulgaris).
The blood starfish (Cribrella sanguinolenta).
The snake starfish (Ophiopholis aculeata).

The last two species are so distinctly different from each other, and from the first two, that there is no difficulty in identifying them. Neither species is harmful to the shell fisheries.

The common starfish and the related purple star vary so much with regard to color, shape of arms, size, number of species, etc., that the French naturalist, Perrier, has made five distinct species of Asterias to include those starfish along our coast, which, according to the American naturalists L. Agassiz, Stimpson, and Verrill, belong to two species only.

I have endeavored during the last year to ascertain whether some of these varieties were to be explained as a difference in sex, but I have been unable to discover any such relation, and am not able to distinguish males from females except by the sexual products.

II. *What is the geographical and bathymetrical distribution? (The reply to these questions will indicate the area subject or most liable to invasion.)*

Geographical distribution. (Only the first two species are considered in this report.) The purple star ranges from Labrador (probably further north) to Cape Hatteras, and is most common north of Cape Cod. The common star ranges from Maine to the Gulf of Mexico, and is the species most common south of Cape Cod.

Bathymetrical distribution. Purple star; high water to 208 fathoms. Common star; high water to 20 fathoms.

From the numerous dredging expeditions of the U. S. Fish Commission launches and the steamer "Fish Hawk", carried on last summer, it appears that in Narragansett Bay the purple starfish

(Asterias vulgaris) is practically restricted to the lower portion of the Bay, below Gould Island. Occasionally, of course, a specimen may be taken farther north. One specimen, for instance, was taken near Dyer's Island, among a thousand or more of the common species. I have never known a single specimen among the thousands of bushels of starfish captured on the oyster beds which are located in the upper half of the Bay. The common starfish, on the other hand, occurs in greater or less abundance everywhere from Fox Point to the mouth of the Bay, and is the only species that commits depredations upon our oyster beds. (The purple star would doubtless be destructive if it were present.) The starfish taken from the vicinity of the oyster grounds are, moreover, very similar to one another in appearance, as compared with those which may be collected in one locality at Woods Holl. At this station one haul of the mops may bring up stars which apparently belong to half a dozen quite different varieties.

There are other varieties differing from those found on our oyster beds, and from the purple starfish, which seem to be characteristic of certain localities. Thus, at the head of Buzzards Bay, at Ney's Neck, a large number of specimens of common star were collected, which were very similar to one another, but quite different from those found on our oyster grounds. They had very large coarse spines, and were of a bronze color. The specimens taken by the "Fish Hawk" in the waters south of Narragansett Bay (see other part of this report, p. 35) seem to constitute a variety ("maroon star") which occupies this area to the exclusion of other kinds of stars.

It is not known certainly whether each of these so-called varieties is an actual variety in the sense that the individuals breed true, or whether the peculiar appearance is due merely to the fact that the individual stars are bred and reared in a particular locality.

If it should prove to be true that the young of a certain variety, e. g., the maroon star, are always like the parent stars, no matter where they grow, we might be able to determine to what extent the starfish are dispersed while in the free-swimming larval condition. We will refer to this question again in Chapter X.

MODE OF LIFE.

III. *What is the method of locomotion? (It is possible that some barrier might be arranged that would limit, if not prevent, invasion.)*

The starfish crawls or glides over submerged surfaces by means of the very numerous "suckers," or feet, which protrude from the furrows on the under side of the arms.

Small stars, one-half inch or less from tip to tip, are frequently seen, ventral side uppermost, moving along with their suckers reaching to the surface of the water. This performance can be carried on only when the water is very quiet, and is not often observed outside the aquarium. The buoyancy of the water and the great number of sucking feet enable the animal to crawl over the softest silt and the smoothest hard surfaces with ease, while the remarkable suppleness of the body enables it to get through incredibly small crevices. Beside this ordinary mode of locomotion, another peculiar method has been accredited to the starfish by many: namely, that of clinging together in great clusters and rolling along the bottom with the tide.

For the purpose of testing the ability of starfish to creep over soft surfaces, vaseline was smeared thickly on a vertical glass plate and on the under side of a horizontal glass plate. These plates were submerged in the aquarium with the starfish which measured two or three inches from tip to tip. The animals were observed to crawl over both these surfaces with no apparent difficulty. Paraffine was used in the same way and with the same result. It would appear, therefore, that submerged surfaces, though ever so soft or slippery, would not be effective barriers against the invasion of starfishes.

As was stated in the last report, starfishes will not crawl out of the water, nor even protrude an arm above the surface. They will, however, move along over a surface covered with a very thin layer of water, even if it is not deep enough to cover the whole body. The animals are perfectly secure, therefore, in a disk of water as shallow as a soup plate, so long as the water does not flow over the edge. But if they are placed in an aquarium which is constantly overflowing, they will frequently crawl over the edge and down on the outside. No barrier, therefore, over which even a thin layer of water is flowing, would be effective.

IV. *Are the starfish which are reputed to appear in schools in any way different from those known to occur naturally in a particular locality?*

I have thus far not had an opportunity to examine the starfish reported to appear in schools.

V. *To or from what distance may starfish migrate?*

This is a problem which has a decidedly practical bearing, but we have as yet very little accurate data for its solution. I have been told by several oystermen that the starfishes sometimes suddenly appear in great numbers upon the oyster beds, and move over them at the rate of a quarter of a mile per day, more or less. It is generally understood, moreover, that there is some sort of a seasonal migration especially noticeable at the spring and fall, but the character and extent of this migration, if it really occurs, is unknown.

If a starfish crawled constantly in one direction, at the rate of six inches per minute, which is a fair rate for a medium sized specimen, it would travel about four miles in a month. At this rate starfish could go from one end of the Bay to the other in the course of the summer. But there is no good evidence that they do take such extended excursions. The fact that stars can be found all the year round in the upper part of the Bay, and on the oyster beds, shows that there is not a wholesale migration to any great distances. There are some other facts which seem to indicate that the wanderings of these animals are rather limited in extent. Certain kinds of starfish which are common in one part of the Bay are not found, or are rare, in other parts. The purple star and "maroon star" do not migrate into the upper half of the Bay, although the purple star, at least, might live in these waters, as I have found by keeping them in confinement. The starfish in two neighboring parts of the Bay, namely, Mt. Hope Bay and Kickemuit river, do not seem to migrate back and forth, for those caught in Kickemuit river, during the past two years at least, were for the most part small, rarely measuring more than three inches from centre of disc to tip of arm, yet about a mile from the mouth of this river there have been great quantities of very large stars with arms four inches long or more. In Barrington river there seems to be a great preponderance of small stars about two and a half inches (arm) or less, which are of a reddish-brown color, and so are distinguishable from the average starfish caught in the vicinity of Nayatt. After the great freshet in the spring of 1888, the starfish in Kickemuit river nearly all perished, Mr. Bourne tells me, and did not become again troublesome for three or four years.

These facts, though they are not conclusive evidence, lead to the conjecture that there are natural barriers to the migrations of starfishes in our Bay. Some of these barriers may be: the depth of water, density of water, or a strip of barren bottom.

If the conjecture is correct, that the migrations of the starfish are confined to comparatively limited areas, the prospect of diminishing their numbers by a systematized effort is encouraging.

VI. *What animals are devoured by the starfish for food? (If the young starfish feed habitually upon certain animals, it is possible that the destruction of the latter will cause the former to perish.)*

Abstract. The starfish, especially when young, are exceedingly voracious feeders, prey upon oysters, clams, mussels, barnacles, various kinds of sea-snails (including oyster drills), worms and small crustacea, and, if slightly pressed by hunger, turn cannibal and prey upon smaller starfish.

It was found during the past summer that the starfish in Mt. Hope Bay and in the vicinity of Nayatt were feeding in great numbers upon a little bivalve which closely resembles a young quahog. This little animal, however, is not a young quahog, but an adult mollusc of another species—Mulinia lateralis. Fig. 1 represents a large specimen drawn natural size. The "Fish Hawk" found these animals to be exceedingly abundant during the last season in certain parts of the Bay.

Mussels are a favorite food of the stars, and doubtless many thousand bushels of mussels are devoured by them every season.

Indeed, some of the mussel beds have disappeared within the last few years, having been destroyed, probably, by the starfish. Unlike the oyster beds, the mussel beds are not protected from the onslaughts of the stars, and we can appreciate the extent of the damage to the mussels, if we imagine the condition of a bed of small oysters unprotected from the starfish for a single season.

In rearing the young stars for the purpose of studying their rate of growth, etc., I found them to be very fond of small clams and barnacles, as well as of young oysters. I will speak in more detail of the damage done to the young clams by the starfish in another chapter.

I have caught starfish in the act of devouring oyster drills, and believe it probable, therefore, that the drills, which are a serious menace to the oysters in some localities where the starfish are rare, are to some extent held in check by the stars.

VII. *What is the method of feeding?*

This question has been satisfactorily answered by Dr. Schiemenz, a German, and a brief review of the results of his work, as well as some of the current opinions on this topic, were given in the report of last year. The point of Schiemenz's results is as follows: The starfish grasp both valves of the shell fish, and by persistently exerting a constant, steady strain, finally fatigue the muscles holding the valves together so that they gap open slightly. Then the stomach is protruded between the shells, and the soft body of the mollusc is digested. Frequently I have noticed that small animals are taken into the stomach through the mouth, which is able to stretch to a surprising extent. On one occasion I found, on cutting open a starfish, that it had swallowed a clam whose shell was so large that I could not push it back through the ring of bony plate which surrounds the mouth.

VIII. *At what season of the year do the starfish spawn? (If at a particular season, a special effort should be made to kill the animals before spawning, and thus destroy both stars and spawn.)*

I have attempted by two methods to determine the spawning season of the starfishes in the upper portion of our Bay and at Woods Holl. The first method consisted in examining a large number of adult starfish at intervals during the year, to see if they contained ripe eggs and milt. The second method consisted in dragging a fine silk " tow net " at surface of the water, to catch the free-swimming young.

Most of the adult starfishes examined were obtained through the kindness of the oystermen in Kickemuit river, Mt. Hope Bay, and the vicinity of Rocky Point. The observations on the condition of the eggs and sperm were begun in July, 1897. On the 19th and 22d of this month 630 stars were carefully examined, and the sizes of the specimens (taking always distance from mouth to tip of arm), and of the sexual glands, were tabulated. The specimens ranged from 1¼ to 3½ inches (31 to 90 millimeters). Of these, fifteen specimens were found to contain eggs or sperm which was apparently ripe. In some, only one arm contained ripe products. None of these apparently ripe specimens were smaller than two inches. In the great majority of the specimens the sexual glands were small, less than one-half the length of the arm.

During the remainder of the summer, stars from these localities were frequently examined, and occasionally a specimen was found with ripe eggs, but there was no general increase in the size of the glands.

On November 15 a lot of stars from Rocky Point were examined. They were nearly uniform in size, and measured about three inches. In about one half of these specimens the glands were half the length of the arm, but none were ripe. Among the seventy-five specimens, measuring approximately three inches, collected at the same place November 29, fourteen seemed to be nearly mature; the glands in forty-four of the others were half the length of the arm. The remainder had small and immature glands.

January 6, 1898, Rocky Point: About forty stars, 3½ to 4 inches in length, were examined. Of these only four had sexual products which seemed to be nearly ripe, while the majority seemed less mature than in November.

January 7, Kickemuit river: Fifty stars, ranging between 2½ and 3½ inches (four specimens measured 4 inches). In twenty specimens the glands were considerably developed, but not nearly ripe. In the remaining thirty they were quite small.

January 15, Kickemuit river: Fifty stars, measuring from 2½ to 3½ inches were examined. In general, there was, perhaps, a slight increase in size of glands, though in over thirty they were very small.

February 9, Rocky Point: 126 stars, measuring from 2½ to 4 inches. In three specimens the sexual products were ripe; in ten, nearly ripe; in fifty-three, large and turning color, becoming slightly pink; in forty-seven, small, but showing signs of seasonal development; in twelve, very small.

February 12, Kickemuit river: Sixty-three specimens, measuring from 2 to 3½ inches. In six the glands were large and beginning to show a pink color; thirty-nine showed seasonal development, while eighteen were very small.

March 4, Kickemuit river and Mt. Hope Bay: Thirty-nine specimens, 2½ to 3½ inches in length. One specimen was apparently quite ripe; twenty-six seemed nearly ripe; the glands in seven were beginning to change color; in three, immature but showing seasonal development; in only two specimens were the glands very small.

March 7, Rocky Point: Ninety-nine specimens, measuring 2 to 3½ inches. Five specimens were apparently fully ripe; seventy-one specimens nearly ripe (very large glands); in twenty, the glands showed the pink color slightly; in two the glands were small, but showed seasonal development; only one specimen had very small glands.

It is evident that, during the latter part of January and throughout the month of February, there is a regular increase in the size of the sexual glands in nearly all the starfishes from Rocky Point, Mt. Hope Bay, and Kickemuit river. By the end of the first week in March, the great majority of the stars have the appearance of being nearly mature, while the remainder, except in a few specimens, show a distinct seasonal growth in the sexual glands. The stars are at this time beginning to look "fat," because of the increased size of these glands and of the digestive glands, usually called the "liver," which fill the arms.

April 5, Rocky Point: 197 specimens examined, varying in length from 2 to 4 inches. Of these, 137 had the appearance of being fully ripe; 32 were nearly ripe; in 20 the glands were beginning to show the pink color; in 9 they were smaller, but showed seasonal development; in one only were the glands very small.

April 13: Twenty-five specimens, out of a basketful from Mt. Hope Bay, were examined. All seemed to be ripe, and so the examination was not carried further.

Although at this time, i. e., during the first two weeks of April, the stars are all *apparently* ripe, they do not discharge the products for about two months. During this time they have the appearance of being extremely "fat."

On May 17, the stars were examined again in Kickemuit river and Mt. Hope Bay, and appeared very much as in April. They were, perhaps, more distended with spawn and milt, but had not yet discharged.

During the first four days of June, starfish from many localities in the upper portion of the Bay were examined on board the launch "Sagitta," engaged by the United States Fish Commission. The stars were, almost without exception, full of very ripe eggs and sperm, which were easily shaken loose in the water. Small specimens, measuring, in many instances, only an inch and a quarter, were fully ripe.*

The height of the spawning season occurred between this date, June 4, and June 16. From June 16 to June 28 the starfish examined in many localities, especially at Kickemuit and Rocky Point, had extruded most of their eggs, or sperm, but in some specimens the ripe spawn was found in one of the arms, or merely in the base of the arms, as though not quite all had been extruded. Specimens in which some ripe products were left were more frequent on the 16th than on the 21st, 22d, and 28th of the month, which indicates that the spawning season was rapidly drawing to a close.

Starfish examined in July, and occasionally during the rest of the summer, yielded the same results as those examined at the same season in 1897; most of the specimens had very small sexual glands, but some were found with products apparently ripe.

Young Stars. On the 22d of June, I searched carefully on the sea-weed and ell-grass in Kickemuit river for very young stars; not a single young star (under ½ inch or more) could be found.

A week later, on the 29th of June, another careful search was made in the same locality, when I found countless numbers of very minute starfish, most of them about the size of the head of a pin. They were clinging by the dozen to every spear of ell-grass, and scattered diffusely through the branches of fluffy sea-weed, which is abundant in this locality. The larger of these little stars was probably not more than a few days old (since time of setting) as I afterward determined by watching the growth of those whose exact time of setting was known. Doubtless, therefore, the small stars were absent, and not overlooked, in the search on June 22. I feel sure, therefore, that in this locality the starfish first began to set, in considerable numbers, on June 28, or within a day or two of that date.

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* See Chapter on "age and size at sexual maturity."

Free-swimming larval stars. The first attempt to capture the starfish in the free-swimming stage of their existence was made in the evening of June 27, at Kickemuit. The tow-net was dragged at the surface at intervals for two hours in the evening. The conditions of the weather were unfavorable, as I afterward learned, and for this reason no young starfish were caught. On the following morning, June 28, a great number of fry were found swimming at the surface of the water. From this date until July 16 they could be captured at any time, unless the conditions were particularly unfavorable. The few larvæ caught on July 16, however, were old, and all of them set in the aquarium during the next twelve hours. After this no more larvæ could be obtained, although the next few days were exceptionally favorable.

It is evident, therefore, that in Kickemuit river the season during which the starfish larvæ set in considerable numbers began about June 28 and ended about July 16, a period of a little less than three weeks. Allowing that the larvæ set three weeks after the spawn is laid (which is the period given by Ingersoll), we may conclude that the beginning of the spawning season was about June 7, and the end June 28, while the height of the season was the first, and possibly the second, week in June. From the observations of the sexual glands of the adults, it appeared that the greater part of the spawn was extruded during the 4th and the 16th of June. The facts, therefore, obtained by both of these methods agree very closely. Through the kindness of Dr. Seitaro Goto, of Tokyo, Japan, who worked in Mr. Agassiz's laboratory at Newport in 1895, I have obtained the following interesting data. For one or two days before the 15th of July, the larvæ had been very numerous. On the 15th they were decreasing in number and after the 20th of July none were found. At Newport in 1895, therefore, the breeding season was nearly the same as that at the Kickemuit river in 1898.

At any time in the year a few starfishes may be found which contain ripe eggs and spermatozoa, but it is not known that these eggs are laid out of season. If they are, the chance of their becoming fertilized is small. Dr. Goto writes me that a similar phenomenon is seen in a Japanese species of sea-urchin. He is able to obtain ripe eggs and sperm, and to fertilize the eggs artificially, even in the midst of winter, though the species probably does not breed in these waters at that season.

Summary. To answer briefly the question asked at the beginning of this chapter, we may say: The starfish in the upper portion of the Bay, and probably throughout the Bay, have a short spawning season, which begins about the second week in June and continues for two or three weeks. The young fry begin to set during the last week in June, and continue to set until the middle of July. The fact that ripe starfishes may be obtained in very small numbers throughout the year is of no practical significance, for if such specimens lay their eggs out of season, the chances are comparatively slight of their being fertilized.

Observations were made at Woods Holl, from March to the end of the summer. It is rather difficult to interpret the results satisfactorily, for at no one period were more than a small proportion of the stars at Woods Holl ripe, or even approaching a ripe condition, and, on the other hand, a few ripe specimens could be found at any time. As a rule the sexual glands were very small, like those of the Narragansett Bay stars in mid-winter, and it was noticeable also that in such specimens the digestive glands were also unusually small. The latter condition I take to be an indication of poor nourishment, judging from the condition of poorly-fed stars kept in confinement, as compared with well-nourished specimens. I am inclined, therefore, to assign the failure to breed to the same cause.

In this connection I may observe that in the specimens kept over winter at Kickemuit, with very little to eat, the sexual glands did not approach the ripe condition. An examination of the stars taken in February and March from Narragansett Bay shows that by this season of the year they are eating voraciously, shells, and even fragments of starfish, being found in their stomachs.

In some previous years the stars have bred in abundance at Woods Holl, but the notes on the time of breeding are somewhat puzzling, as they indicate that the time varies considerably.

IX. *What are the habits of the "fry" of free-swimming young? (The young of many marine animals, while far more abundant than the adults, are far more delicate and easier of extermination.)*

The ripe eggs of the starfish are minute spherical objects, measuring about one-tenth the diameter of the head of a small pin. They are discharged from the female through minute pores near the base of each arm, free, into the water, where they may become fertilized by the spermatozoa discharged from the male in a similar manner. Each egg, soon after it is fertilized, commences to undergo a long series of changes in form. During the first stages of development there is little or no increase in size, and the egg rests, like a minute grain of sand, upon the bottom. In the course of a few hours, however, the internal changes which have been taking place express themselves. Vibratile cilia appear in certain areas on the surface of the egg, which now begins to rotate, and soon rises from the bottom as a free-swimming larva. Soon after this the mouth and stomach are developed, and the creature takes in food and grows. The growth is rapid, and during the next three weeks, more or less, the larva increases its diameter about fifty times. Meanwhile various internal organs and several long arms, and other external features, are developed. The older fry are called brachiolaria, from the fact that they have so many long arms. One of these brachiolaria of the largest size is represented in Fig. 2, much magnified. The natural size is shown in Fig. 4, where two specimens are figured, one on either side of the bit of eel-grass. The animal swims by means of the motile cilia, which are arranged in bands, represented by the heavy lines in the figure. They form a complicated pattern over the surface of the body, and extend out upon the arms. The body is quite transparent, and the tips of the arms, which are shaded in the figure, are light red. The larva represented in Fig. 2 is old, and would probably have set within twelve hours. Already the rudiment of the resulting starfish, the disc-shaped body at the bottom of the figure, can be seen within the brachiolarian. The five crenate lobes on the margin of the disc are the beginning of the five arms. The disc itself at this time is already somewhat opaque.

When the larva is about to "set" it attaches itself to some object, like a spear of eel-grass, by the suckers, shown at the top of the figure, and then a rapid transformation occurs. The whole superstructure above the disc collapses and becomes absorbed like the tail of a tadpole. In a few hours the brachiolarian has disappeared, and a starfish proper has taken its place.

Although the free-swimming larvæ have a considerable power of locomotion, and can swim from one side of a dish to the other in a few minutes, they can not, of course, make headway against the tidal currents, and are carried hither and thither with their ebb and flow.

Other extensive movements of the larvæ are executed in response to such changing conditions as those of light and temperature; at a certain time myriads of them are swimming at the surface of the water, and in twelve hours not one specimen can be found. The brachiolarian, like more lowly organized forms of living creatures, although it has no eyes, is exceedingly sensitive to light, being attracted to it sometimes, and again being repelled by it. According to my experience, they were found at the surface in greatest abundance on cloudy or misty days and nights, and were much more rare, or absent altogether, on bright clear days and moonlight nights. On the evening of June 27th, for instance, I skimmed the surface with the tow-net from nine until eleven o'clock, and not a single larval star was found, though there were millions of the larvæ of the annelid worm Syllis, and other organisms. The night was clear, with bright moon, and the tide was rising. The next morning, June 28th, was cloudy, with some rain, and large numbers of the larvæ were taken in the nets, between 8.30 and 10 o'clock. In the evening of this day, between 9 and 11 o'clock, they were even more abundant than during the day. The evening was calm and cloudy, with a little rain. Afterward I met with the same experience on several occasions.

Another question in respect to the movements of the free-swimming larvæ is of practical importance, inasmuch as they are thousands of times more numerous than the adult stars. To what distances may the larvæ be carried by the tides and currents in our Bay? I cannot answer this question directly, but there are certain facts which have an inportant bearing upon it.

Although the purple stars (Asterias vulgaris) are common in the lower portion of the Bay in the vicinity of Newport and Seaconnet, they seem to be totally absent from the upper parts, although the adults, at least, can live in these waters. I have kept them for a long time in Kickemuit river. This would seem to indicate that the larvæ of the purple stars are not transported by the tides from the lower to the upper portion of the Bay. It may be, of course, that the larvæ, unlike the adults, cannot abide in the upper portion, or that the young stars, as soon as they can crawl, return to the southward unnoticed; this seems to me, however, to be improbable.

The distribution of some other marine animals whose habits are similar to those of the brachiolaria is of interest in this connection. At Waquoit, about ten miles northwest of Woods Holl, on the Vineyard Sound side, the water was fairly alive with the young of a certain species of jelly-fish, which could be taken from this locality in immense numbers at any time for several weeks during the spring. At Woods Holl, however, these specimens were comparatively rare.

Again, later in the summer, at Menemsha Bight, near Gay Head, another small jelly-fish was found in such great abundance that every bucketful of water contained thousands of specimens, yet they were exceedingly rare, if present at all, at Woods Holl.

In the upper part of Buzzard's Bay, at Ney's Neck, the starfish probably bred in great numbers, judging from the appearance of the adults earlier in the spring, yet the larvæ were rarely caught at Woods Holl.

These facts, and others of the same nature, certainly suggest that the larval starfish may not be transported to great distances in the Bay by the tides.

X. *What is the duration of the larval period?* (*If an effort is to be made to destroy the larvæ, when must it be made?*)

The reply to this question has been given in detail, in chapter VIII, p. 48. Briefly stated, the larval period of an individual star is probably about three weeks. (The precise length of time could be ascertained only by keeping certain larvæ under observation and in normal conditions from the time the egg is fertilized until the larvæ set.) The period during which the larvæ may be found in the water extends from about the second week in June to the third week in July, according to the observations last year. There may be a slight variation from year to year, as in the case of other marine animals. The larvæ set in very great numbers, about the 28th of June last year. An effort to destroy the larvæ would be more effective, therefore, during the last of June, when the spawning season is practically past and the setting has not begun.

XI. *What are the habits of the young starfish?* (*It is possible that the young starfish, like the young of many fish, tend to gather in schools. If so, the young might be killed off in thousands.*)

The data with reference to the habits of the young stars were collected at Kickemuit, where I was able to have a certain area along the shore under constant observation.

Up to the very time when the larvæ are ready to set, they swim freely in the water, and I have often caught larvæ in the tow-net which set in the dish of water before I returned to the house-boat, *i. e.*, within an hour of the time they were caught. In this condition they attach themselves by their suckers (see Fig. 2) to any object they happen to strike, and cling to it with great tenacity, until the metamorphosis is completed. As the larvæ are borne along by the currents, the eel-grass, rock-weed, and especially the fluffy, branching sea-weed, naturally catch immense numbers of them. I think it would not be an exaggeration to say that on a single handful of sea-weed which I picked up about the first of July there were more than a thousand young stars. For the next three weeks they remain for the most part crawling about over this vegetation, gradually working down among the roots of the rock-weed, and on-to the large stones at the bottom. They grow rapidly during this time, but decrease in numbers, for they are bright and conspicuous objects for the small fishes. Nevtheless, they are exceedingly numerous for a long time. In order to obtain a definite expression of their abundance, I scooped up a large handful of the fluffy sea-weed, which, together with the water, about two-thirds filled a paper pail, and my friend Neal Bourne picked off from this 603 young stars. The average size was about that in Fig. 9. A cart-load of sea-weed taken out at this time would have destroyed millions of starfish.

By the first of August the fluffy, branching sea-weed, which bore so many young stars, was nearly all dead, and though the stars were still present in great numbers, upon the eel-grass, rock-weed, and stones covered with sea-moss, they were also frequently seen crawling along the muddy bottom.

By the 15th of August the eel-grass was overgrown and lodged by a luxuriant growth of Botrylus, a compound ascidian, which appears as dark gelatinous patches. The small stars were still numerous upon it, but were rather thin and poor. The greater portion of the stars had left the eel-grass, and were searching for food upon the stones and along the bottom; these were larger and better nourished than those which remained upon the eel-grass.

The small starfishes, such as live upon the eel-grass, are remarkably hardy in some respects. They will live for weeks and even months, in a small dish, without change of water, and with the minimum amount of food. During the first week in July I carried a number of free-swimming brachiolaria, like the one figured, to Providence, for further examination. They were carried in a glass one-quart butter jar, and, after one or two specimens were taken out, the jar was closed and left on my desk unopened during the rest of the summer. In a few days the larvæ had all set, and when I examined the dish again, on September 5th, it contained still a few live starfishes, which were, however, very small. Upon watching these specimens it was observed that the more enterprising individuals were eating their companions, and finally only one star remained. This one lived in the jar for weeks, but, unfortunately, I am not able to record the exact date of his death.

On the other hand, the same young starfishes, which can live so long without food or change of water, perish quickly if left out of the water, especially if the sun is shining. They cannot live, therefore, above the low-water mark, unless sheltered by a dense growth of vegetation. Large starfish can endure very much longer exposure, since their bulk prevents their drying so quickly.

On July 16th I made a special search for young stars, on the sea-weed, above the low-water mark. I found none, yet just below low-water mark they were excessively abundant. At the same time it was noticed that, above the line where the starfish were abundant, there was a thick set of one-year-old oysters, while below it the oysters were absent. The oysters set somewhat later in the season than the starfish, and the latter, therefore, are ready to prey upon the young oysters as soon as they appear. When, in addition to these facts, we take into account the extraordinary voracity of the young stars, their immense numbers, and their special fondness for oysters, we are led to conclude that one reason why a considerable set of oysters is so rarely obtained below low water is that they fall prey to the starfish. The oysters which set above high water are comparatively safe, for when the tide leaves them uncovered they can endure for hours the direct heat of the sun, which would kill the young starfish in a few minutes.

While the starfish are living upon the eel-grass and sea-weed they are supplied with an abundance of food in the form of the young of marine worms, snails, and other animals, which, like the stars themselves, swim freely in the sea for a time, and then settle down upon any object with which they happen to come in contact. Throughout July the water at Kickemuit was teeming with minute free-swimming creatures, and, in the aquarium, the growth of the youngest stars could be greatly accelerated by feeding them the contents of the tow-net. During the last four days of June innumerable larvæ of a marine worm, Syllis (?), were swarming at the surface, and on July 11th millions of the young of one of the sea-snails, Littorina (?), were caught in the tow-nets.

The clam, also, is one of those unfortunate animals whose larvæ set at about the same time as the starfish, and in the same places. The starfish before they are three days old show a predilection for young clams, which apparently does not diminish so long as any clams remain. Fig. 3 was drawn from life last summer by Dr. J. L. Kellogg, and represents a characteristic scene in the marine tragedy.

In order to ascertain how fast the stars of the average size found upon the eel-grass would devour the young clams of average size, I placed one such star in a dish with fifty-six clams taken at random from the margin of a stone. The larger clams were about the length of one arm of the star, and they ranged from this length to one or two millimeters. The experiment was begun at 1:22 P. M., on July 18; at 5:40, P. M., two clams had been devoured, each about the length of the arm of the star, and during the evening a third was eaten. At eight o'clock the following morning five had been eaten; at nine o'clock, six; and, at 9:05, the seventh clam had been attacked. I was absent from the laboratory for the next four days, and returning on the 22d found, at 6, P. M., twenty-nine empty shells whose contents had been eaten by the starfish. The starfish had grown considerably, and was eating faster than formerly, for on the next day thirty-nine empty shells were found, and on the day following this forty-six were empty, while ten more had disappeared altogether, having doubtless been devoured shell and all at some time during the week. To make sure that the clams were killed by the stars, and did not die from some other cause, a control dish of clams was kept, in which all the specimens lived. *In six days the one starfish devoured over fifty clams.* Both starfish and clams represented the average size at this season. I regret that I did not record the exact dimensions of the starfish at the beginning of the experiment. Fig. 11 shows about the size of the star at the end of the experiment, on July 25th.

When we recall how exceeding numerous the starfish are, and that they are found in the same localities with the young clams, the result of this experiment becomes the more significant. At this rate the six hundred specimens taken from the one netful of sea-weed would devour thirty thousand clams in six days. The starfish in a cart-load of sea-weed, if it contained two hundred small fork-loads, would have the capacity for destroying over six million clams in a week.

Summary: The starfish set for the most part during the last few days in June, and the first week in July, some as late as the 16th of July. They remain upon the sea-weed in immense numbers until about the first of August, when many of them are found upon the bottom. By the 15th of August the greater portion of the stars have left the sea-weed and taken to the bottom. The young stars do very great damage, not only to the young oysters, but to the young clams.

The destruction of the starfish by the hundreds of thousands could be effected by collecting and drying a few cart-loads of sea-weed taken below low-water mark, in the month of July. After the first week or two of July the collection of the seaweed would not do any injury to the clams.

XII. *What is the rate of growth up to sexual maturity?*

The observations and experiments bearing upon this question were made at the Kickemuit river, and these methods were adopted:

A. A large number of starfish were kept under constant observation and surrounded with natural conditions as far as possible.

B. Frequent observations were made upon the starfish in their natural environment.

C. Individual starfish were reared under various conditions, and their growth recorded from time to time.

D. Starfish which were regenerating lost parts were kept under various conditions, to determine the rate of growth and the rate of regeneration.

A and B. On June 29th a bunch of sea-weed, on which were hundreds of small stars, was placed in a car at the house-boat. All the stars were very small. The greater number were about the size of that in Fig. 5, but they ranged from the size shown in Fig. 4, just setting on the eel-grass, to that in Fig. 6.

On July 15th it was found that hundreds of stars had crawled through the wire netting, and were thickly scattered about on the under side of the car. Here they had found an abundance of small barnacles, which to all appearances they very much relished. After preserving a few specimens, to compare with those taken from the sea-weed, the rest of the stars were left unmolested upon the bottom of the car. The average size of the stars on the car was greater than the average of the larger specimens on the sea-weed. This was doubtless due to the fact that the former were better fed. A difference in shape was also striking, those on the car being more plump. Figures 7, 8, and 9 represent three specimens taken from the sea-weed on this date, and Fig. 10, one of the larger specimens (3 m. m. from mouth to tip of arm) from the car, all natural size. The measurements which follow are all taken from mouth to tip of arm.

On July 18th the stars showed a very appreciable growth. One of the larger specimens, measuring 5 m. m., is represented natural size in Fig. 11.

On July 24th one of the largest stars measured 8 m. m., and was preserved. See Fig. 12.

On July 26th one could see an appreciable growth since the 24th, and the specimen shown in Fig. 13 measures 9 m. m. In eleven days (since July 15th), therefore, there has been an increase of three hundred per cent. in the length of the arm, which is equivalent to a much larger increase in bulk.

The stars were taken from the bottom and put inside the car on August 1st, and were fed with barnacles and small mussels. They had by this time eaten nearly all the barnacles on the bottom of the car, and were doubtless in want of food.

On August 2d the largest specimen measured 11 m. m., and is represented in Fig. 14. Those on the bottom, however, which had left the eel-grass, were larger, some of them approaching the size of those on the car.

On August 13th a box thickly covered with barnacles was split up and pieces put into the car. The starfish always preferred the under side of the boards, and the latter were therefore placed barnacle side down.

The stars on the eel-grass were examined on August 15th and the larger ones averaged about 2½ m. m., or about the size of that in Fig. 9.

On August 18th the largest specimens measured slightly less than 18 m. m. (See Fig. 15.) This specimen was afterward kept in a dish without food, and will be referred to again.

On September 5th one of the largest specimens was 26 m. m. in length of arm. (Fig. 16.) Another specimen measured 27 m. m., and several measured 25 m. m. or more.

On September 26th the largest specimen measured 35 m. m., and is represented in Fig. 17.

On October 12th the largest specimen found was 42 m. m. (Fig. 18.)

On October 25th one specimen was found which measured 54

m. m., or about 2¼ inches (Fig. 19). This specimen was preserved. (The next largest was 51 m. m.) It is shown in Fig. 19 and is the largest star reared in captivity. It was almost exactly four months old, having set about the 28th of June. The sexual glands were more highly developed than usual even for larger stars at this season.

From this date to November 11th there was no growth, but apparently a slight decrease.

The following gives in brief the measurements of some of the largest stars found upon the car during the summer and fall. The asterisk * indicates that the specimen was not returned to the car, so that a smaller specimen was recorded on the next date.

July 15.	*July 18.*	*July 24.*	*July 26.*	*August 2.*	*August 18.*
3	5*	8*	9	11	18

September 5.	*September 26.*	*October 12.*	*October 25.*	*November 5.*
27	35	42	54*	......
26	35	40	51	45
26	34	40	50	44
25	33	38	48	43
25	33	36	45	43
25	31	35	45	43
24	30	35	44	42
24	30	......	......	40
24	......	......	......	......
23	......	......	......	......

On September 5th a number of specimens (nineteen in all) were picked out and placed by themselves in another car, so that I might be sure to measure the same individuals on succeeding days. These were measured on six occasions, with the following results:

Sept. 5.	*Sept. 26.*	*Oct. 12.*	*Oct. 25.*	*Nov. 5.*	*Nov. 11.*
24	35	40	47	46	41 (?)
24	31	35	40	38	41
20	30	35	38	38	40

Sept. 5.	*Sept. 26.*	*Oct. 12.*	*Oct. 25.*	*Nov. 5.*	*Nov. 11.*
19	29	34	38	38	39
19	29	33	38	38	38
19	28	32	37	38	38
18	28	32	36	38	36
18	28	31	36	37	36
18	27	31	36	37	35
18	26	30	36	37	35
17	26	30	35	37	35
16	26	30	35	37	35
16	25	29	35	34	35
16	25	29	35	35	35
15	24	28	34	33	34
15	23	28	32	33	34
15	21	27	30	32	33
14	21	25	30	32	31
12	21	.....	29	31	31

It will be noticed that among these specimens, as well as among those in the original car, given in the first table, there is rarely any evidence of growth after October 25th, but there is rather a slight decrease in size. On each occasion the measurements were made without referring to those of the preceding date, so that no personal prejudice might enter the results. For the most part the figures indicate a fairly uniform rate of growth among the different stars. In interpreting these figures, there is one factor which is to be taken into consideration, namely: that starfish over 20 m. m. (sometimes less) are able to contract and expand, so that two careful measurements, taken within a few minutes of each other, may vary as much as one or two millimeters. The measurements in the last three columns, therefore, indicate that the starfish in the car were of about the same size on November 11th as on October 25th. The first measurement (41 m. m.) on the bottom of the opposite page, under November 11th, is doubtless an error.

It may be inferred, from what has already been said, that at any time during the summer, after the stars are all set, there is a great difference in size among them. To illustrate this point, I arranged on August 18th a series of specimens taken from the car and from the sea-weed, and photographed them at natural size, by laying them down on the sensitive paper (with a thin transparent film between), and then exposing. The variation in size is shown in Fig. 20, the first five specimens having been taken from the car and the last five from the sea-weed. This variation in size is without doubt due much more to the difference in the amount of food than to the difference in age. The following experiments on the rate of growth of individual starfish support this view.

C. Rate of growth of individual starfishes kept under various conditions. The starfish which was the largest of those in the car on August 18th (compare Fig. 15) was kept in a dish with only a few very small barnacles for food. When taken from the car it measured 18 m. m.; slightly more when fully expanded. On September 25th it measured 18 m. m., showing no growth. On September 26th, thirty-nine days after it was taken from the car, it measured between fifteen and sixteen m. m. In the absence of food, therefore, it had lived and apparently was in perfect health, but had probably diminished somewhat in length, as well as in bulk. (Some allowance must of course be made for the contraction and expansion, as mentioned before.) During this time several of the stars, smaller than this one, remained in the car and grew to the length of 35 m. m. (Fig. 17.)

A small starfish which was caught in the tow, and set on June 28th, was kept in the dish with many others until June 23d. On this date it was placed in a small dish by itself and fed with small clams and barnacles. Fig. 21 shows the growth of this specimen: A. 2 m. m., July 23d; B, 4 m. m., August 13th; C, 4½ m. m., August 18th; D, 5 m. m., September 6th. On September 6th it was transferred to a car where there was an abundance of small barnacles. Fig. 21, E (12 m. m.), represents size on September 26th; F, 21 m. m., on October 12th; G, 30 m. m., on November 5.

As a control to this experiment, several starfish, which also set on June 28th, were kept with a minimum amount of food. One of these, photographed at natural size on September 6th, is shown in Fig. 22 A, while the largest star in the car (with plenty of food) is represented in Fig. 22 B (27 m. m.). The specimen figured in A is thirty-nine days old, and that in B is within a day or two of that age.

The next experiment (illustrated by Fig. 23) on the growth of stars was as follows: On August 3d two stars of average size were taken from the original car and placed in another car with a bunch of mussels.

On August 3d (1) = 7 m. m. Fig. A.

On August 16th (2) = 10½ m. m. Fig. A′.

During this time the stars had little or no food, since they could not, or would not, eat the mussels. On August 15th a lot of barnacles were placed in this car, and by September 5th the results of the new food were evident enough:

Sept. 5: (1) = 15 m. m., Fig. C (one arm was torn off in measuring). (2) = 19 m. m., Fig. C′.

Sept. 26: (1) = 28 m. m., Fig. D (new arm 10 m. m. measured from mouth, growth of 7 m. m.) (2) = 29 m. m., Fig. D′.

Oct. 12: (1) = 36 m. m., Fig. E (regenerating arm, 20 m. m., from mouth, growth of 17 m. m.) (2) = 41 m. m., Fig. E′.

From August 3d to August 16th, while these specimens were not growing at all, those in the car grew about 6 m. m. These two specimens afterward, however, having more food and no interference in eating it, made up this difference, and by September 26th had grown as much as those in the original car.

One interesting point which is brought out by the experiment is that a star which is regenerating an arm may grow as fast as a complete star. Compare next experiment.

C. Rate of growth and rate of regeneration. The starfish, like the lobster and many crabs, has the habit of dropping off an arm which has been mutilated, and of regenerating a new one. Unless the arm is mutilated or some other shock administered, one may sometimes tear a star in two by pulling on the arms, while the latter still remain on the fragments of the disc. On the other hand, if the suckers are cut off from one arm, or the arm is crushed or cut several times, it will usually drop off, always at the same point near the disc, taking the sexual glands with it.

On the 26th of September five of the larger stars in the original car were deprived of the arm opposite the "eye," or madreporic plate, and then placed in a car with barnacles for food. The subsequent measurements show that they kept on eating and growing at about the usual rate, like the specimen similarly treated in the last experiment described. The measurements are given in tabulated form below, the first measurement indicating the length of the longest arm.

	Sept. 26.		*Oct. 12.*		*Oct. 25.*		*Nov. 5.*		*Nov. 21.*	
		New Growth.		New Growth.		New Growth.		New Growth.		New Growth.
A	32	0	36	3	42	7	41	11	40	12
B	30	0	35	3	38	7	41	12	40	11
C	28	0	30	3	35	7	38	10	38	12
D	27	0	29	3	30	6	35	9	38	11
E	25	0	28	3	..	..	34	7	35	9

A comparison of the table with that on page 61 shows that these stars, which are regenerating an arm, grew at about the same rate as the complete stars during the same period. The rate of regeneration was also about the same as the rate of growth in the original arms, except that toward the last the new members grew in some cases somewhat more rapidly.

Another experiment was made, similar to the above, except that two arms were taken off instead of only one, and the stars were younger at the beginning. The stars were at first all about 12 m. m. The eight detached arms were put in the car also, and on September 10th, twenty-six days after they were detached, five were still alive and apparently in good health, but had neither grown nor shown any sign of regeneration. One is figured natural size in Fig. 24 B.

The growth of these specimens is tabulated below. (Measurements were made from mouth to tip of new arm, but figures in table indicate merely new growth, and are derived by subtracting 3 m. m. from original figures.)

	Aug. 15.	Sept. 5.			Sept. 26.				Oct. 12.				Oct. 26.				Nov. 5.			
	Longest arm.	Longest arm.	1st Short arm.	2d Short arm.	Longest arm.	1st Short arm.	2d Short arm.	Newest arm.	Longest arm.	1st Short arm.	2d Short arm.	Newest arm.	Longest arm.	1st Short arm.	2d Short arm.	Newest arm.	Longest arm.	1st Short arm.	2d Short arm.	Newest arm.
A........	12 (?)[1]	22	..	8	34	18	17	..	42	32	30	..	..	..	..	..	..	..	..	..
B........	12 (?)	20	..	7	30	17	17	..	36	26	26	..	..	..	..	..	43	31	31	..
C........	12 (?)	18	..	5	25	9[2]	9[3]	..	37	16	15	..	..	..	..	..	40	24	24	..
D........	12 (?)	18	..	5	23	14	12	8[4]	32	22	20	13	35	23	23	17	34	27	27	20

[1] It was intended at first to keep account only of rate of regeneration, and so four stars were picked out, of about the same size, and one only was measured. This was 12 mm. The others may have been one or two millimeters larger or smaller. The growth of this specimen and the size of the single arm alone, on September 26, are given in diagram Fig. 24, *A* and *B* respectively.

[2] One detached arm still alive—measures 7 mm.

[3] Tips cut off and arm slit on September 15. The longest arm was then 22 mm., and the regenerating arms 15 and 10 mm. respectively.

[4] Arm broken off, probably by handling, on September 5.

This experiment shows conclusively that when even two arms are lost the growth of the starfish is not necessarily arrested or the rate of growth diminished. The rate of growth in the new arms was greater than in the original arms, and there was a tendency, therefore, for all to become ultimately of the same length (Table D, October 12 to November 5).

Summary: The results show clearly that within very broad limits it is impossible to tell the age of a starfish from its size. Starfishes of all ages are able to live for months with very little or no food. The rate of growth depends directly upon the amount of food eaten. Starfishes which are regenerating one, or even two arms, may, under ordinary circumstances, grow as rapidly as complete stars. The growth of the new arms, in the starfish experimented upon, was slightly more rapid than that of the original arms, showing a tendency in the organism to return to the original length. In four months from time of setting, some of the larger stars kept in the cars under favorable circumstances attained a length of from 50 to 54 mm., or 2 to 2⅛ inches, measured from mouth to tip of arm. This is more than twice the length of many of the stars which were found just before the beginning of the breeding season, and which were therefore at least nearly a year old.

Allowing a moderate amount of growth during the winter and spring months, of 10 to 15 mm. (the amount of increase attained in one full month preceding October 12), the larger year-old starfish in the early summer would be about 65 millimeters, or 2½ inches, in length, which is about the length of the greater number of stars taken on the mops in the Kickemuit River during the summer. (Fig. 19, a; 19, b.)

XIV. *What is the size and age at sexual maturity?*

Among the starfish caught in various parts of the Bay on June 2, 3, and 4, several specimens only 1¼ inches, or 32 mm., were found to be very full of sexual products. This size was attained by many of the starfish reared in the car on September 26, about three months from time of setting. See table on page 60. Great numbers of stars, measuring about 2 inches, or 50 millimeters, were found ripe the first week of June. This was the size of several specimens in the car on October 25, which were not more than four months old, and whose sexual glands were well developed. In other words, a large number of the starfish reared in the car were by the end of October as large as a great many which were sexually mature in June. Moreover, it was rare to find a specimen of this size on the first of June which was not full of ripe eggs which were laid later, as the empty starfish caught in July showed. It is an obvious conclusion, therefore, that, with fairly good opportunities to obtain food, the starfish becomes sexually mature in less than one year, and that those hatched one season breed the next.

In his monograph on North American starfishes, Alexander Agassiz gives his views with reference to the rate of growth of the starfish in the following words: (The figures referred to represent specimens, all of them smaller than that in our Fig. 9, of a star about two weeks old raised in the car.)

> "The young starfishes figured on this plate (Pl. VIII) were all found attached to roots of Laminaria, thrown up on the beaches, in the neighborhood, after a storm; and from their different stages of growth, as compared with the oldest starfish raised from a Brachiolaria (Pl. VI. Fig. 11) specimens of which were also found upon these roots, it is probable that the sizes here figured are one (Fig. 1), two (Fig. 8), and three (Fig. 10) years old. A considerable number of specimens were picked up in this way, and they could all be arranged into very distinct groups, representing the starfishes of the present and two previous seasons. There seemed to be no gradation from one group to another, such as we have among the young sea urchins, which, in consequence of their manner of breeding during the whole year, form series, the relations of which it is impossible to determine. In this connection I would say, that by arranging the starfishes found upon our rocks into series according to their size, we are able to obtain a rough estimate of the number of years required by them to attain their full development; this I presume to be somewhere about fourteen years.* They begin to spawn before that time, as specimens have been successfully fecundated which evidently were not more than six or seven years old. It is during the fourth year that the rate of growth seems to be most rapid. A young starfish, measuring one and a half inches across the arms, was kept, during five months, alive in Mr. Glen's tank at the museum, and during that space of time it grew to three inches."

It will readily be seen that my observations do not at all agree with those of Agassiz. I found no difficulty in obtaining all possible gradations in size among the stars in the late summer, and the stars represented by Agassiz as one, two, and three years old respectively, more nearly correspond with those raised in cars when they were one, two, and three *weeks* old.

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* For an account of the method adopted by Professor Agassiz for ascertaining the age of many of our marine animals, see Proceed. Essex Inst., 1863, p. 252.

XV. *What are the natural enemies of the starfish?*

The destructive agents and natural enemies referred to in the last report were cold and fresh water, various fishes which feed upon the larvæ, gulls and crows, and parasites.

Some of the specimens which were being attacked by the parasite frequently found in the fall of 1897 were kept over winter, and by spring the disease had disappeared. The effects of the disease were visible, however, in some cases. In one starfish an arm was entirely eaten through, about ¾ inch from the tip, but was not thrown off. The stump healed over, and the star was kept throughout the year and is probably still alive. It showed almost no trace of regeneration, probably from the fact that food was rarely taken by the specimen.

The enemy which is doubtless the most destructive to the starfish is the menhaden. In an article on the "Food of the Menhaden," published in the United States Fish Commission Bulletin, XIII, 1893, Dr. James I. Peck showed that this fish feeds exclusively upon the minute organisms which swim or float free in the water. The open mouth of the menhaden has an area of about one square inch, and as the fish swims through the water with open mouth and gill covers raised, a considerable column of water is passed through the mouth every minute (estimated by Dr. Peck at about seven gallons). The gillrakers strain the water, and the organisms which are not too minute are caught in the mouth and swallowed. The starfish larvæ of even small sizes are far too large to pass through the gillrakers. Numerous schools of menhaden feed in our Bay during the season when the starfish larvæ are swimming at the surface, and undoubtedly destroy them by thousands of millions.

After the stars are set they are no longer in danger of being destroyed by the menhaden, but for several weeks are bright conspicuous objects upon the seaweed and eel-grass for eels and many small fishes to feed upon.

XVI. *Is the popular idea that the dismembered fragments of a starfish will regenerate new starfish founded on fact?*

This idea is commonly held, and is apparently founded on the fact that in nearly every lot of stars brought up in the dredges or on the mops a considerable percentage of stars may be found which are regenerating lost parts. Frequently two, three, or even four arms are being regenerated, and these are much smaller than the original arms. Upon careful examination and inquiry into the extent of this regeneration, I have never found a well authenticated case among our species of stars in which part of the disc was being regenerated, except those reared with great care in the aquarium. With this point in view, I have examined a large number of regenerating stars caught in their natural haunts, some of them reported to be regenerating part of the disc, but invariably the regeneration was limited to the arm. I have, however, made a few experiments in the aquarium and in the cars, which have a bearing upon this question of regeneration.

The fact that a mutilated arm is frequently loosened and dropped off at a particular point near the base, and the rate of regeneration of specimens which have thus lost one or two arms, are recorded in a previous chapter, page 63.

All the arms may be pulled off, and, if the star is protected and fed, all will generate. Such a specimen is sketched in Fig. 25. This specimen was kept, after the operation, in a glass dish with frequent changes of water, and was fed upon the soft parts of crabs, etc. The regeneration was slow as compared with that given in the previous tables, the new growth shown in the figure (which is natural size) requiring about five or six weeks, probably owing to the comparatively small amount of food taken.

Since a mutilated arm drops off from the disc so readily, the latter nearly always remains intact, and in ordinary cases, therefore, if two stars were to result from one, one of them must regenerate from a single arm. I have several times kept single arms for a long time in the aquarium or cars, but have never seen any trace of regeneration in them. On May 11 several arms were taken off at the usual line of detachment, and kept alive in the aquarium until June 9, when they showed no sign of regeneration. One of these was still alive on June 25, and at that time was apparently enjoying good health, and would turn over if put on its back. It had lived, therefore, for over six weeks, but showed no sign of regeneration.

Another experiment was started on August 15; two arms were taken off from each of four specimens. The rate of regeneration of these specimens is given in the tables on page 65. On September 10, nearly three weeks afterward, five of the single arms were found alive, but showed no regeneration. On September 5 the new growth in the arms regenerating from the disc was from 8 to 5 mm. On September 26, six weeks after the operation, one of the single arms was found alive (7 mm.) It had not shown any traces of regenerating a new arm, although it had healed. This arm is represented natural size in Fig. 24, B, and the new growth which took place on one of the stars from which these arms were detached is shown in Fig. 24, A. Similar experiments were tried last year with the same result. In a recent article by Miss Helen Dean King, in Roux' Archiv, it is stated that single arms were kept alive for two weeks, but never showed signs of regeneration.

Several experiments were carried on to determine what regeneration would take place if the disc were cut through. On May 11, nineteen specimens about 2½ inches in length were treated in the following manner: Two arms were pulled off, and at the base of one of the arms a piece was cut out from the top of the disc in the manner shown in Fig. 26. These specimens were placed in a large car at Woods Hole without food (except what could be carried in the water). On June 9 there was a trace of regeneration in some of the arms. On June 25, a little more than six weeks after the operation, all the arms were growing out anew, and varied from a mere trace of a new arm with the terminal eye-spot (which always shows first) to arms ¼ inches (about 7 mm.) long. This experiment shows two things: that the new arm will regenerate if a portion of the disc is absent, and that the rate of regeneration, like the rate of growth, in normal specimens, is dependent upon the nourishment, for, while the new growth in these cars was only 7 mm. in six weeks, those which were well fed at Kickemuit gained a new growth of from 13 to 18 mm. in the same time. See page 65.

Other experiments were tried, to determine what regeneration would take place if the whole starfish were cut through in various ways, while the arms were left in place. It will be seen that the results were not always the same.

In the summer of 1897 several stars about 2½ inches in length were cut through so as to leave three arms and part of the disc on one piece, and two arms and part of the disc on the other. The smaller pieces perished, but the larger ones lived for several weeks and showed no sign of regeneration. All but one were destroyed by other starfishes, which got into their compartment of the car by accident. The remaining fragment, consisting of three arms and part of the disc, lived several months after the operation and did not regenerate.

On May May 11, 1898, several stars about one inch long were cut as in Fig. 27. One arm was pulled off and the disc then cut in two, leaving two arms with a part of disc and madreporic plate on one piece (=A), and two arms and part of disc on the other piece (=B.) The fate of the single arm has been already considered, page 70. On June 9 all the pieces were alive. In the piece marked A (*i. e.* having madreporic plate) a trace of a new arm arm was visible on the side toward the lost arm, but in no other place. The pieces marked B showed no regeneration at all. On June 25, six and a half weeks after the operation, the condition was as follows: All these parts of specimen 1 were alive. The fate of the single arm is mentioned on the previous page. The piece (A) with madreporic plate is sketched from the lower side in Fig. 28. Two arms were well started, and one minute arm was growing out between them. In the other piece (B) of this specimen, the wound was completely healed, but there was no visible trace of any new arms. Of specimen 2 only one piece (A) was alive. From the stump of the old arm a very small new arm appeared—no trace of any other. The two pieces A and B of specimen 3 were alive and healthy. In A two very small arms were visible (one could be seen only with the help of a hand lens) near together, and on one side of the cut surface; on the other side there was a trace of another arm, indicated by an eye spot. B had healed up, but showed no trace whatever of regenerating arms. Of the fourth specimen piece A was found alive with two very minute regenerating arms. These specimens had very little food, and it is hardly necessary to remark that they grew very little or not at all.

On September 5, 1898, another experiment, similar to the last one, was commenced at Kickemuit River. Eight specimens were taken from those reared in the car, and cut in two in the manner shown in Fig. 29, leaving two arms and the madreporic plate on one piece, and three arms and part of the plate on the other. The pieces of the latter sort died in a short time, and the following tabulated data refer to the pieces having two arms and the plate ("eye"). At the beginning of the experiment the specimens measured in millimeters, 23, 21, 21, 20, 19, 18, 18, 18.

September 26th. (Three weeks after the operation.)

A	20 mm., bore trace of two new arms.
B	18 mm., two new arms (preserved) unhealthy.
C	18 mm., one new arm, 2 mm.
D	Crushed.
E	20 mm., healthy—no trace of another arm.
F	Overlooked. See next, October 12.

October 12th.

A	(?)	23	mm.,	two very small arms.
C		20	"	two arms, one smaller than the other.
E	(?)	22	"	no trace of regeneration.
F		21	"	one arm.
				(all healthy.)

October 25th.

C	20	(?)	two arm 8-10 mm., no trace of other.
E	22		no trace of regeneration.
F	21 20	(?)	one arm, 6 mm.; no trace of another.

November 5th.

A	25	mm.,	two new arms, 2 mm. each.
C	21	"	two new arms, 9-10 mm., no trace of other.
E	22	"	one new arm directly in middle, 1 mm. long.
F	19	(?)	one arm, 4½ mm., no trace of rest.

November 11th. (Fig. 30.)

A	23	mm.,	two small arms, about 3 mm.
C	21	"	two small arms, 10 and 12.
E	21	"	one arm, 1½ mm., directly in middle.
F	20	"	one arm, 6 mm.
			(no trace of other arms in any.)

Some other experiments of a similar kind performed upon young stars about the first of August yielded essentially the same results, with this exception: that out of the seven pieces which lived until September 5, four were those without madreporic plate, and three of these were regenerating new arms. Miss King, whose recent article has been already referred to, seems to have had better success than I, and says that from each of the pieces of a star cut in two a new star may be formed by regeneration.

That the madreporic plate is not essential to the life of the starfish, at least for a very long time, is shown by another experiment. This organ was removed from five large stars on June 14, and on November 5 one of them was alive and healthy, but had not regenerated the lost structure. The madreporic plate was wanting in one specimen caught at Woods Hole on April 4. Another specimen was taken which had an accessory madreporic plate, which was not, however, connected with the stone canal. In the last report, I mentioned an experiment in which this body was extirpated and regenerated before the end of the season.

Summary: In every known case of regenerating starfish caught on the mops and in dredges, the new growth is limited to the arms. The arms are readily loosened and cast off when injured, but almost certainly do not produce new stars, as is shown by the experiment in which single arms have been kept for six weeks without trace of regenerating, and by the fact that single arms regenerating the rest of the stars have never been found among this species of star (they are common in some foreign species). Starfish which have been cut in two behave differently in different cases. They may live for a long time without regenerating the remaining arms to the slightest degree; they may show no sign of regeneration for several weeks, and then regenerate one or more arms; they may soon regenerate only one or two of the arms when three are required to complete the original form of the body. The rate of regeneration and perhaps the possibility of regeneration are dependent on the food supply, like the rate of growth. It is probably possible for two or more complete stars to result from one, but in many experiments in which the stars were carefully protected this result has not been obtained by me. The probability of this result occurring when stars are torn apart and thrown overboard is doubtless very slight, for, as the experiments show, such stars have difficulty in obtaining food, and are especially liable to injury and to destruction by other stars or enemies of various kinds.

XVII. *What are the artificial methods of destruction now in use in Rhode Island or elsewhere?*

These methods were given in the last report.

The starfish become easily entangled in the mops, not only because they are rigid and covered with spines, but because the little forceps (pedicellaria) thickly scattered over the surfaçe of the body catch hold of the threads of the mop. If one presses the upper surface of a live starfish against the back of his hand, he will find that these pedicellaria grasp the hairs on the hand tightly, and will sustain the whole weight of the starfish.

EXPLANATION OF FIGURES.

Fig. 1. Mulinia lateralis, gray, natural size.

Fig. 2. Larva of starfish, nearly ready to set, in side view; dark bands show the position of the vibratile cilia; intestine and stomach shaded; five lobes at the lower portion of figure are the beginning of the five arms. From life, much magnified.

Fig. 3. Starfish about two days old, devouring clams. Outlines of the stomach of the starfish can be seen through the transparent shell of the clam. Drawn from life by Dr. J. L. Kellogg.

Fig. 4. Piece of eel-grass with starfish larvæ just undergoing their transformation; two specimens of larvæ at the sides. Natural size.

Figs. 5 to 8. Small specimens of starfish from seaweed about the first of July. Natural size.

Fig. 9. Shows size of average star found upon the eel-grass and seaweed on July 15. Natural size.

Fig. 10. Large specimen from car, July 15. Natural size, 3 mm.

Fig. 11. From car, July 18, large specimen, 5 mm. Natural size.

Fig. 12. From car, July 24, large specimen, 8 mm. Natural size.

Fig. 13. From car, July 26, large specimen, 9 mm. Natural size.

Fig. 14. From car, August 2, large specimen, 11 mm. Natural size.

Fig. 15. From car, August 18, large specimen, 18 mm. Natural size.

Fig. 16. From car, September 5, large specimen, 24 mm. Natural size.

Fig. 17. From car, September 26, large specimen, 35 mm. Natural size.

Fig. 18. From car, October 12, large specimen, 42 mm. Natural size.

Fig. 19. From car, October 25, largest specimen, 54 mm. Natural size.

Fig. 20. Series of starfish taken on August 18, showing variation in size; first 9 specimens from car, last 4 from eel-grass. Natural size.

Fig. 21. Shows growth of single specimen collected as a larva and set June 28. A, July 23, 2 mm.; B, August 13, 4 mm.; C, August 18, 4½ mm.; D, September 5, 5 mm.; E, September 26, 12 mm.; F, October 12, 21 mm.; G. November 5, 30 mm. Natural size. See page 62.

Fig. 22. A, starfish set June 28. Kept alive in dish, and drawn natural size. September 5 (5½ weeks); B, from car, September 5, within a day or two of the age of A (page 63). Both natural size.

Fig. 23. Shows rate of growth in two stars, A, B, etc., and A′, B′, etc.; A and A′, August 3, 7 and 10½ mm.; B and B′, August 16, 7 and 10½ mm.; C and C′, September 5, 15 and 19 mm. (one arm pulled off from C); D and D′, September 26, 28 mm. (new arm 10 mm.), and 29 mm.; E and E′, October 12; E. 36 mm. (new arm 20 mm.); E′, 40 mm. Natural size. See page 63.

Fig. 24. A, rate of growth and of regeneration; I, August 15; II, September 5; III, September 26; IV, October 12; B, single arm alive, from August 15 to September 26. Natural size. See pages 64 and 70.

Fig. 25. Star regenerating five arms from ventral side. Natural size. See page 69.

Fig. 26. Showing manner of cutting the stars in the experiment described on page 70.

Fig. 27. Showing manner of cutting the stars in the experiment described on page 71.

Fig. 28. Showing the regeneration of the arms in the experiment described on page 71; a portion of the disc regenerating three arms. Natural size.

Fig. 29. Showing the manner of cutting the stars in the experiment described on page 72. Natural size.

Fig. 30. The result of one of the regeneration experiments described on pages 72 and 73; one or two arms regenerating from a part of the disc. Natural size.

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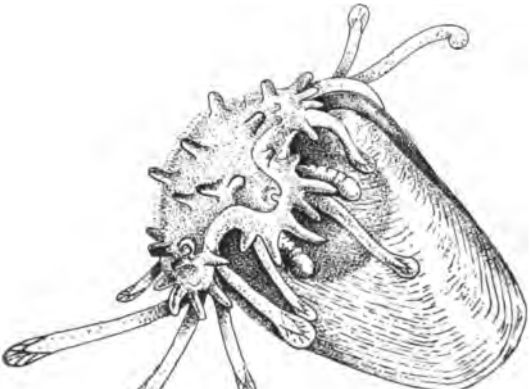

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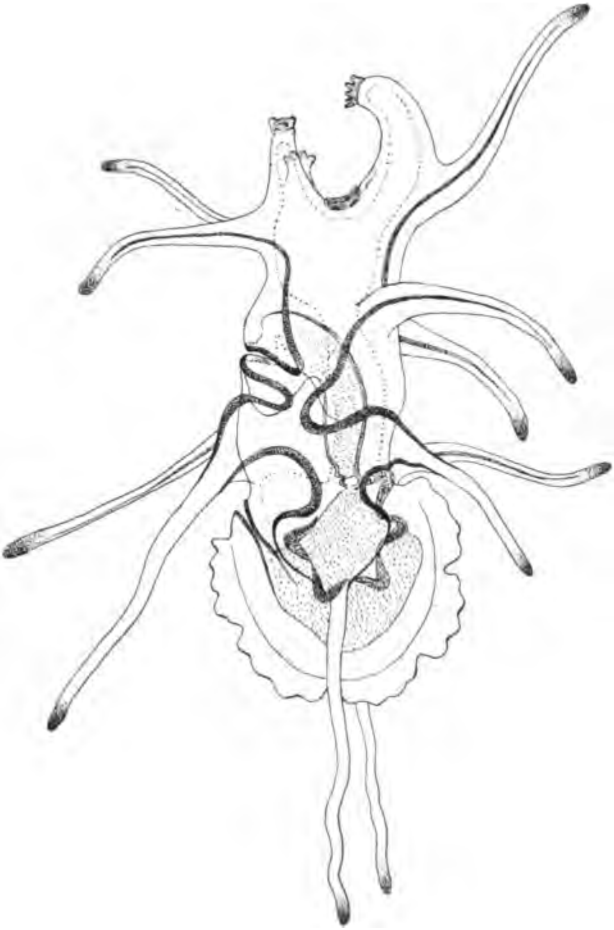

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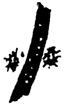
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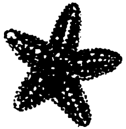
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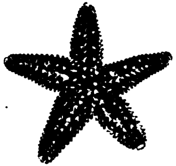
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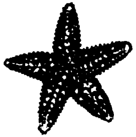
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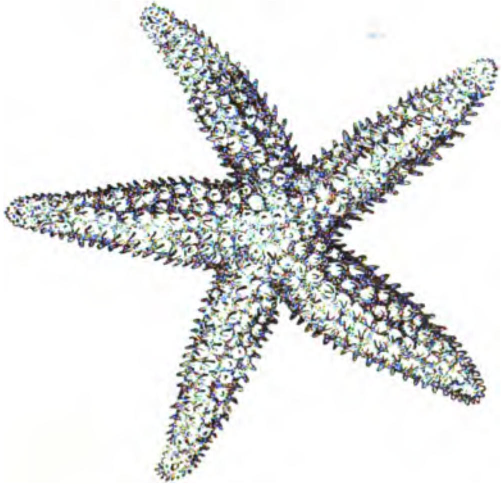
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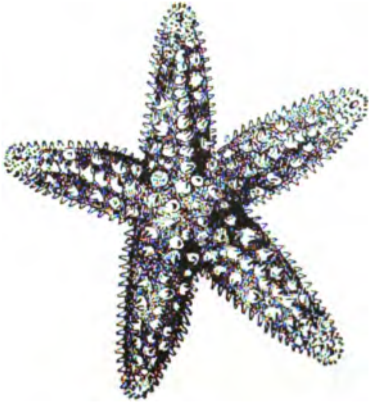
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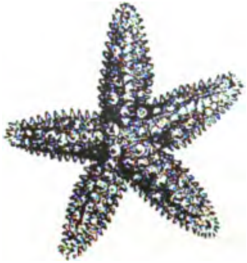
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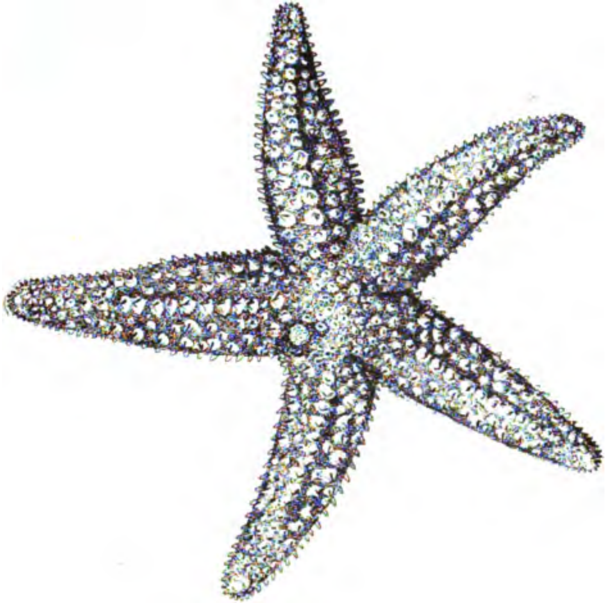

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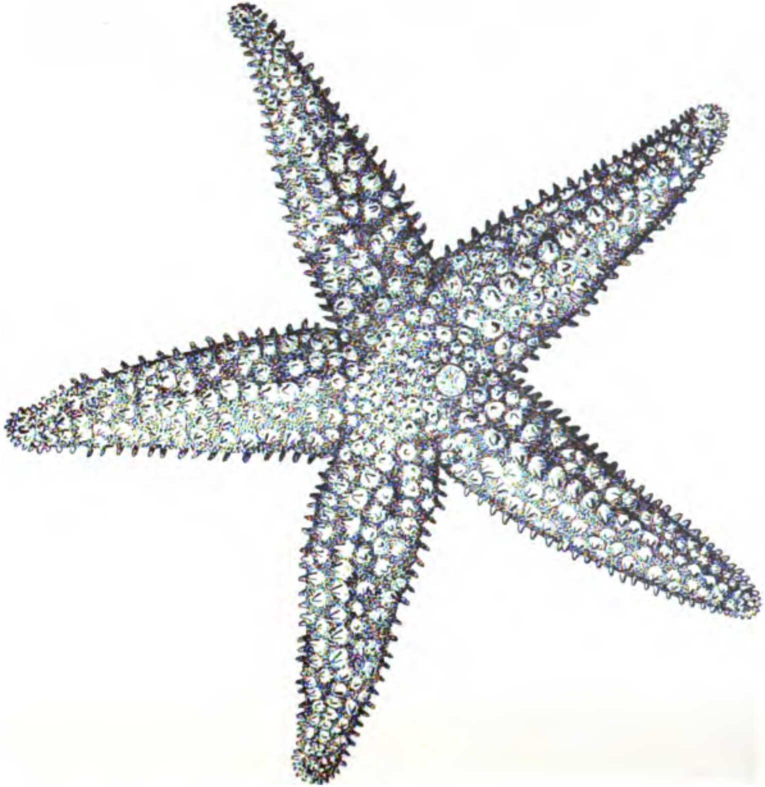

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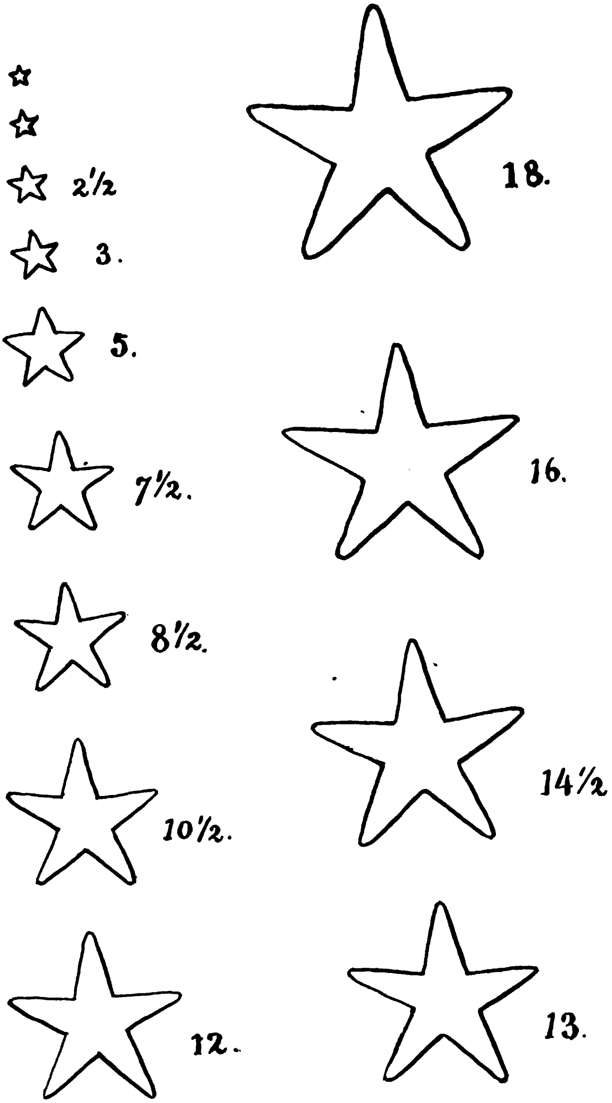
Fig 20.



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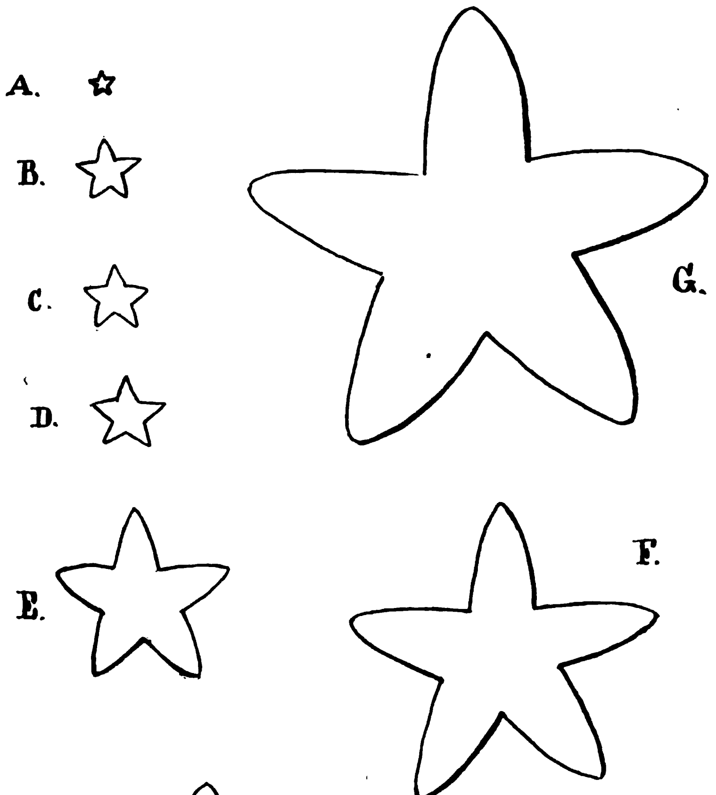


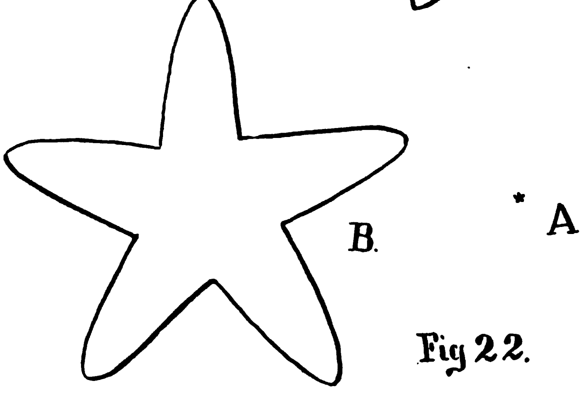
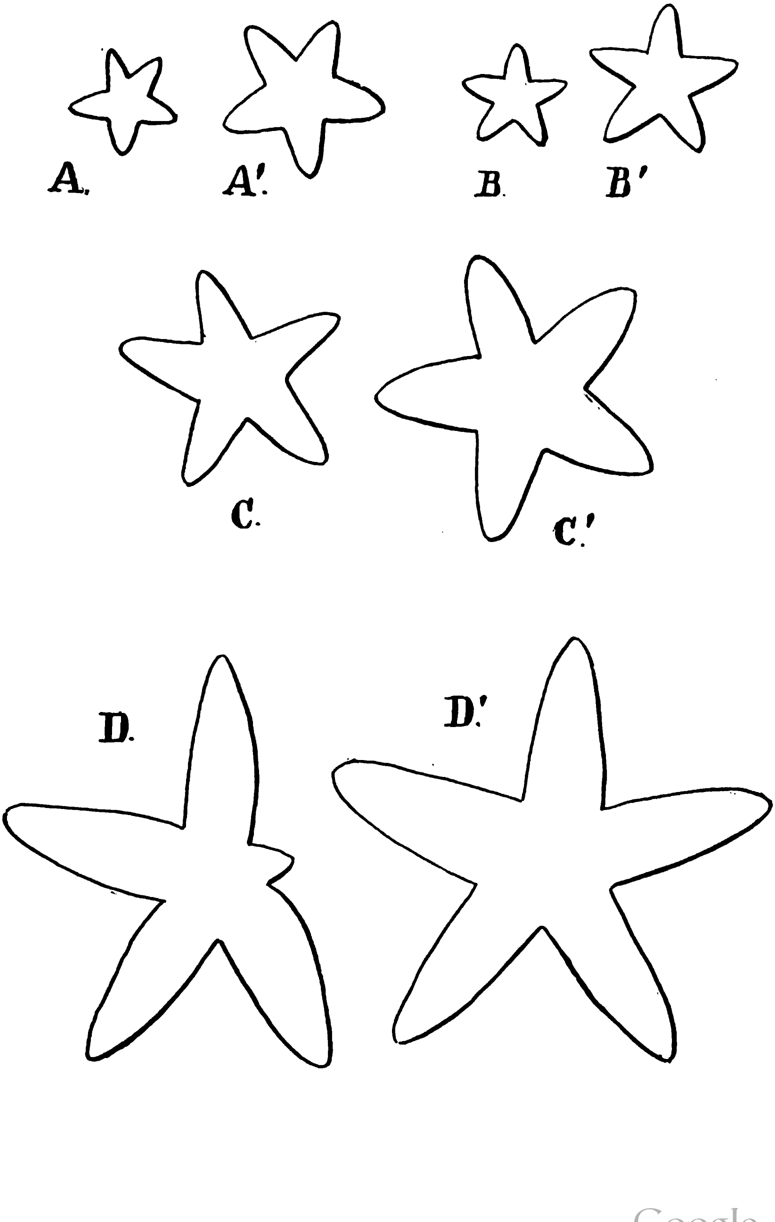


Fig 22.

Fig 23.



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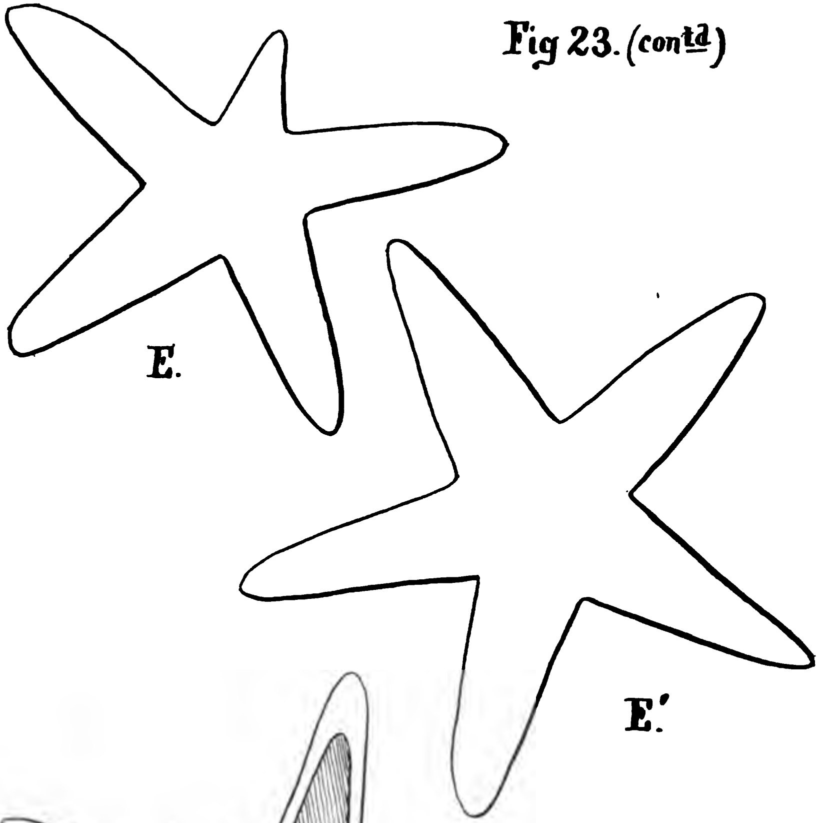


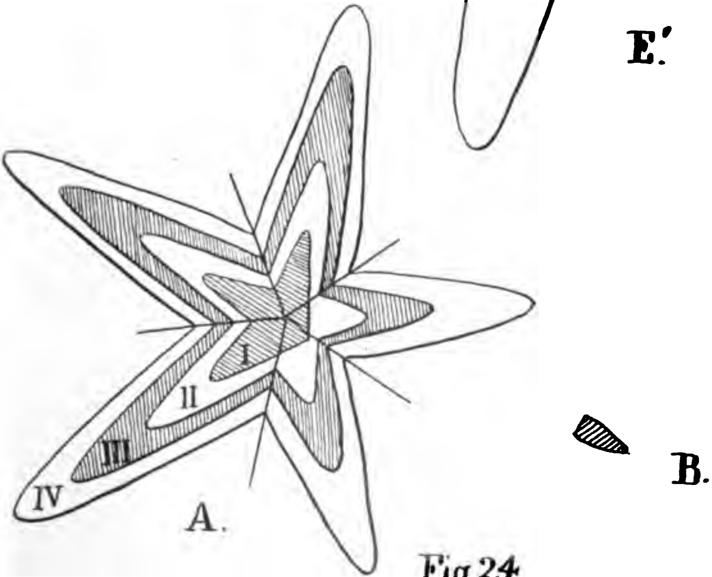


Fig 24.

Fig 25.

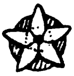


Fig 26.

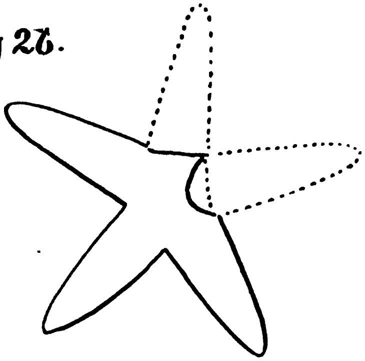


Fig 27.

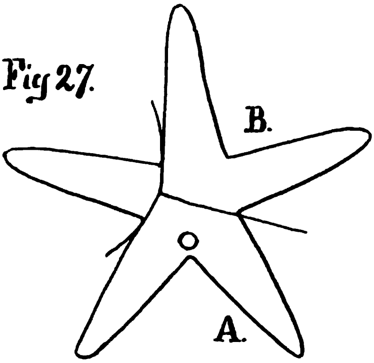
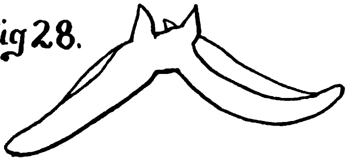


Fig 28.



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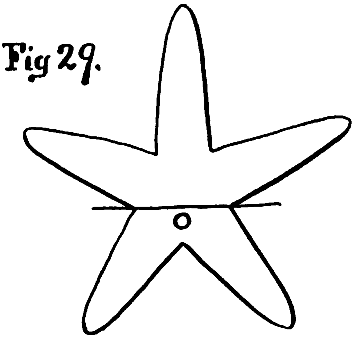

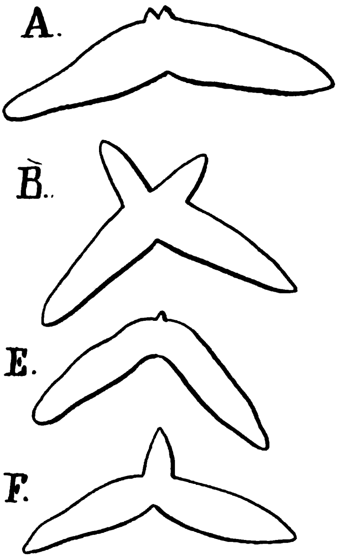

Fig 30.

IX. *A study of the life-habits of the clam.*

This investigation has been undertaken for the purpose of determining the reasons for the present depleted condition of the clam beds, and to test the feasibility and practicability of restocking the same through methods of artificial propagation. The investigation was entrusted to Prof. J. L. Kellogg, who has made a special study of the lamellibranchs (the natural group to which the oyster, clam, and scallop belong), and who is amply qualified to write authoritatively respecting the various problems of marine life.

SPECIAL REPORT

ON

THE LIFE-HISTORY OF THE COMMON CLAM,

MYA ARENARIA.

BY PROF. JAMES L. KELLOGG.

On several occasions in past summers I have noticed, in June and July, on the eel-grass and *Ulva* in the vicinity of Woods Hole, Massachusetts, some very small bivalves which were attached by a byssus. The outline of the shell was such as to suggest a similarity to the long necked, or soft clam, *Mya arenaria*, and yet the differences were considerable so far as form was concerned. The whole outline was rounded, and the umbones prominent and widely separated, while in the adult clam the shell is elongated from before backward, the inconspicuous umbones approaching each other closely near the median line. The character of the hinge might have determined the matter, but it was so small and fragile in the few specimens which I had picked up in the search for other material, that examination was difficult and uncertain. I had always had a suspicion, however, that a study of these forms would show them to be the young of our common clam.

Among the numerous notes and papers by the late Professor John A. Ryder, of the University of Pennsylvania, I find a short description of the young *Mya* attached by a byssus.* A few individuals were found in New Bedford harbor by Vinal N. Edwards, of the U. S. Fish Commission. These forms were attached to floating timbers, together with masses of ascidians (*molgula*). Professor Ryder, in his study of them, found in a few specimens, a single byssus thread arising from a byssus gland in the foot.

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*American Naturalist for January, 1889, embryological notes.

Being invited by Dr. H. C. Bumpus, of Brown University, who represented the Rhode Island State Fish Commission, to make some investigations on the life history of the clam during the summer of 1898, I proceeded to Woods Hole, Massachusetts, to consult with him in regard to the work. Soon after my arrival, I was informed by Dr. A. D. Mead, who had just returned from the Kickemuit River, in Rhode Island, that he had observed a small bivalve in great numbers in the seaweed in which were also to be found the small starfish which he was engaged in studying. On proceeding to the "River," I found the creatures which I had previously seen at Woods Hole in countless numbers attached by a byssus thread to the matted filaments of the marine alga *Entermorpha*, and rarely to *Ulva* and eel-grass. The *Enteromorpha* was attached to the long blades of the eel-grass, and to stones on the bottom, and was found only near the beach, which contained a great many clams. The small lamellibranchs I soon determined to be the young of *Mya*, and the following is an account of their development and habits from the period of their fixation by the byssus thread to the adult condition.

Not being able to reach the shore before the last of June, I was unable to obtain material for the study of the embryonic stages of the development.

SOME STRUCTURAL PECULIARITIES OF THE SMALL CLAM.

Many of the attached forms were extremely small. Several were obtained which were but $\frac{4}{15}$ of a millimeter in length, and these the unaided eye could with great difficulty distinguish from fine grains of sand. A glance at Figure 2, which represents an individual of this length, shows a creature with little resemblance to the adult *Mya*. The outline is rounded, and the umbones are very prominent, and project out so as to be widely separated from each other. The foot, also, is of the ploughshare shaped variety, found in such clams as *Venus*, *Unio*, and many others, and, though not so represented in the figure, may be seen through the delicate semi-transparent shell to extend over the entire ventral surface of the visceral mass. In this it is very unlike the hatchet-like foot of the adult *Mya*, which is relatively small and projects forward from the anterior surface of the visceral mass. The siphons (8), however, are similar to those in the adult form, but are excessively delicate and filmy, occupying so little space when retracted that the shell does not gape posteriorly to accommodate them. They are protracted and retracted with the utmost facility and rapidity.

It was not difficult, however, to determine that these individuals were young long necked clams. When arranged in a series from smaller to larger forms, very slight differences between contiguous individuals, as regards the outline of the shell, lead from the rounded form with prominent umbones to the elongated shell of the adult, in which the umbones are inconspicuous. This comparison is illustrated in Figure 1. The outlines of the shells of a few individuals have been selected from a much greater series. They represent forms from $\frac{4}{10}$ of a millimeter to 7½ millimeters (less than $\frac{5}{16}$ of an inch) in length. The largest shell differs from that in the adult in having the still conspicuous umbones placed anterior to the middle of the shell, but the general appearance is much the same, and the changes in outline from the one to the other are easily followed in intermediate sizes.

In drawing a great many outlines with a camera, two individuals of the same length very frequently presented differences in outline which were considerable. Everyone has probably noticed how great are these individual variations in the shells of the adult clams, even in those cases where the shells have not become distorted in growth by coming in contact with unyielding bodies, such as imbedded stones. The outlines selected and reproduced in Figure I are, of course, respresentative, and show one or two curious facts which would appear in any similar series.

The first of these is that the small rounded shell, as already described, becomes relatively much elongated. Again, in the shell $\frac{4}{10}$ of a millimeter in length, the umbo appears near the middle of the shell, and then rapidly shifts its position anteriorly as the creature becomes older. In outlines 9 and 10 in the series (in individuals 6 and 7½ millimeters in length respectively), the umbones are being gradually moved back toward the middle of the shell, and this is continued in older shells until, as in the adult, they have again assumed a position about equally distant from the anterior and posterior extremities. This shifting in the position of the umbones is of course due to the fact that the shell for a time grows more rapidly posteriorly, and at a later period the anterior part has a period of more rapid growth.

In shells not longer than 2 millimeters, it is not difficult to detect the usual tooth in the left valve (as well as the excavation in the right), which Gould and Binney describe in the adult as erect, "rounded at its summit, of about equal breadth and height; its inner face is smooth and rounded; its outer face is divided into two portions, the largest of which is spoonshaped, the other flat, and traversed across the middle by a grooved ridge, which projects beyond the margin of the tooth like a smaller tooth." This description may be easily applied to the small shell.

In the smallest forms examined there was a concrescence of the mantle folds similar to the condition in the adult. There can be no doubt, as appears from the enumeration of these peculiar anatomical conditions, but that the small form here described is *Mya arenaria.*

ATTACHMENT.

One of the most interesting features of the life-history of the long necked clam—interesting from an economic as well as from a scientific point of view, as I shall attempt to show—is the fact that it is attached by a byssus to foreign objects during a considerable period of its early life. The smaller forms which I was able to find in the seaweed above the bottom were minute in size, some being but 4/10 of a millimeter in length. In every individual there was to be found a well developed byssus, which afforded a rather firm hold to the filaments of the weed. All the clams in the weed of course maintained their position by the same means, and the largest of these which I found, when I made my first examination early in July, was 7 millimeters in length (a little more than ¼ of an inch). A search early in August revealed several somewhat larger than this, each attached by a byssus, and in the mud of the bottom also many were obtained, some of them from 10 to 13 millimeters in length, which still possessed a well developed byssal thread.

In the note by Professor Ryder, spoken of above, a statement in regard to the size of attached individuals is not quite clear. He says: "As they grew larger it was further supposed that they were held fast in their unusual position by the fibres and cement substances secreted by the mantles of their ascidian neighbors, and thus were suffered to attain a considerable size (from two to fifteen millimeters). * * * However, further investigation showed that in this I was in error, for after a careful search, a few individuals were found from which a single byssal thread was found to proceed." From this statement it does not appear positively that any individual fifteen millimeters long was seen to have a byssal thread attaching it to a floating body, though such possibly may have been the case.

Beginning work early in July, I was unable to find sexually mature adults either in Narragansett Bay or at Woods Hole, the breeding season evidently coming earlier in these localities, probably in May and June. That a few individuals still continue to discharge sexual cells late in July, however, we have evidence in the fact that even in August there appear on the seaweed a few very small forms which must be comparatively young.

We are led to the conclusion, then, that the free-swimming embryos attach themselves to foreign objects, such as the seaweed *Enteromorpha*, to eel-grass, *Ulva*, stones, and other bodies, and that these attachments by the minute clam take place in the months of June, July, and August—the great majority of them in Narragansett and Buzzards Bays in the latter part of June and in early July. Having become fixed in this way by a byssal thread, the clams remain for some time, many of them attaining a length of at least 6 or 7 millimeters, and perhaps more.

FREEING FROM ATTACHMENT.

It may be well to notice, at this point, the fact that the attachment of the clams may be broken at any time, apparently at the will of the animal, by a casting off of the byssal thread. This is a very usual phenomenon among lamellibranchs with a byssus, and may be well observed in the black mussel, *Mytilus edulis*, where the byssus is very greatly developed. Here, as well as in the young clam, all the threads may be cast off from the gland in the foot, and new threads may be produced at will. Apparently young clams of all sizes in the weed very often perform this function. When they have in this way made themselves free in a glass dish, they at once begin to move about by means of the well developed foot. Slowly crawling about for a time, they finally conclude to reattach themselves, and even after this has been accomplished, they often crawl about in various directions to the length of their tether. In this process of freeing and reattachment, however, it often happens that the little clams fall from the supporting weed altogether, and reach the bottom. In order to determine, if possible, how frequently this happened, I kept a large mat of *Enteromorpha*, covered with clams, floating in running sea water. Under the mass was spread some fine cloth. In the course of a week, great numbers—perhaps a fourth of all those attached—were found to have fallen from their support on to the cloth, and these were of all sizes. Here they attach themselves, wander about, and again attach, until, apparently tired of the effort to find congenial surroundings, they remain inert, most of them without byssal threads, for long periods of time.

MIGRATION TO THE MUD.

As one would naturally suppose, this period is a critical one for the clam, as much so probably as any in its history, though the creature has to contend with other great dangers also, which threaten its existence both before and after it enters the mud. The eel-grass on which the *Enteromorpha* filaments grow most abundantly in the localities examined is to be found in shallow water, near the clam beds. In falling from their support, most of the clams would probably find a resting place on the bottom, below the lowest low tide mark. That this actually happens may be easily demonstrated by taking a little of the mud in these localities and washing it through a fine sieve. When this is done the small clams are easily found. It is probably not possible for many of these creatures to reach maturity in this position. I have dug clams below what I should judge was the lowest low tide mark in the salt pond at Wakefield, R. I. On a recent visit to Essex, Mass., I was told by a few of the clam diggers that there were long-necked clams in the bottom of the Essex River, which were always covered by many feet of water. One or two of the diggers believed these clams to be unlike the common long neck in some few details of structure. I was unable to obtain any of the forms for examination, and consequently do not know what this information may be worth. Though it is possible that *Mya* may, in some instances, be found in bottoms which are never exposed, it seems to me altogether probable that such areas are not numerous. Clam diggers very generally seem to know nothing of their existence.

I should conclude, then, that of the great numbers of small clams which fall from the seaweed to the bottom below low tide mark, few are able to reach a favorable position higher up on the beach, and the great majority are destroyed. I have seldom found, in such localities, individuals more than 6 or 7 millimeters in length. While the majority may thus perish, we may well believe that a few, on falling at certain times, are borne by tidal currents above the low tide mark. They are to be found here burrowed into the sand, or attached to the sides of stones, down close to the line where the stone touches the mud. This occurs most often on stones covered by rockweed (*Fucus*), and probably for the reason that here the little clams find better protection from their most destructive enemies, the young starfish. It is possible that some of these small clams between the tide marks originally attached themselves in this position, never having been fastened to objects in the water below low tide mark.

This wholesale destruction of individuals below low water mark is but another example of the tremendous struggle for life to which so many species of organisms are subjected in nature. Of the millions of swimming larvæ that probably arise from one female during a breeding season, few become attached to suitable objects, the water currents carrying most of them away. Those which succeed in fastening themselves are killed in vast numbers by very small starfish; and even after attaining a position in the sand and mud of a favorable locality, the shifting of the sand, the crowding of individuals, the decay of organic material in the water, or the isolation of salt water in shallow arms of the sea, leads to the destruction of many. Considering these phases of the life-history of the soft clam which I have thus far described, it seems that artificial methods might be developed which should remove some of the dangers to be found in nature, and hence lead to a greater increase in the number of adults.

BURROWING INTO THE MUD.

The migration from the point of attachment having been accomplished, we are next concerned with the habit of burrowing into the mud. In the adult clam the foot is reduced to a laterally compressed, finlike projection from the anterior side of the visceral mass, not extending down on to its ventral surface. It is with great difficulty that the mature clam buries itself in the sand after having been dug from its burrow. Clams from one to two inches in length will cover themselves gradually in the course of from half to three-quarters of an hour, but they reach the usual depth of several inches only after a much longer period. Very large clams out of their burrows seem to be entirely helpless. In the young, the foot is relatively very much larger than in the adult, and extends from the anterior side of the visceral mass, just under the mouth, far back on its ventral side. This condition of the foot is almost exactly like that to be found in such a clam as the quahaug (*Venus mercenaria*) in its mature state. *Mya* has probably descended from an ancestral form which possessed this plowshare-shaped foot, its organ of locomotion being reduced to its present form because it became less and less an organ of locomotion, and was used simply for digging downward into the sand. We have a confirmation of this view in the structural peculiarities of the foot in the very small *Mya*, as described above.

In the young *Mya* the foot is capable of great extension, and is used not only in crawling over objects, but also in digging into sand and mud. It is extremely interesting to notice that individuals but 1½ millimeters long (I have not happened to observe it in smaller forms), when placed upon sand, at once attempt to cover themselves by thrusting and worming the sharp anterior part of the foot into it. Unless the sand be extremely fine, clams of this size are not able to thrust aside the grains sufficiently to obtain a lodgment. Those measuring 2 or 3 millimeters in length are sometimes able to cover themselves partially or wholly; while an individual 6 millimeters long can usually work its way beneath the surface of any clam bed, and thus rest in comparative security. All clams which I have observed, under 6 or 8 millimeters in length, work their way downward only far enough to cover the shell. None of them seem to be overly energetic, and many times, after working long enough to raise the posterior end of the shell into a vertical position, they give up the attempt to bury themselves, and remain in that attitude until toppled over by the water currents. After having become completely covered they exhibit a great deal of restlessness, and apparently often push out to the surface again, as if dissatisfied with the surroundings, and, after wandering about for a short distance, once more go down. This process I have known to be repeated, in an individual 6 millimeters in length, half a dozen times in the course of three days. They seem to wander short distances—one or two inches only—between the periods of descent, but I have noticed it in few cases, and perhaps the wanderings on the surface of the bottom may at times be more extensive. How large the clam is before it finally digs into the bottom to remain permanently, I am not able to say. I have frequently found lying on the surface empty shells at least 2 centimeters long which had been perforated by the oyster drill (*Urosalpinx*), which could only have made its attack when the living clam was out of its burrow. Clams of this length, then, apparently have periods of wandering, and it would be interesting to determine, if it were possible, whether or not they would be able to move up between the tide marks from some position below low tide. When dug out of the bed, clams measuring 2 or 3 centimeters in length are generally found to have gone down 12 or 15 centimeters (5 or 6 inches) from the surface, the extremely delicate and filmy siphons of the small individual becoming relatively larger and more muscular. There undoubtedly comes a period—probably not far from this time—when the clam ceases to come to the surface, and, except for some accident, remains forever buried, reaching up to the water only by means of the siphon tubes. Evidence of this we have in the fact that clams are frequently to be found between rocks in such a position that it would be impossible for them to move, having reached such a location when smaller. Then, too, shells, especially the larger ones, are frequently distorted and rendered asymmetrical by coming in contact, in growth, with an unyielding object, such as a stone. The shape in such cases conforms to the space in which movement is possible. This same distortion of the shell may be noticed in other burrowing lamellibranchs, like *Petricola pholadiformis*. In the case of this latter form, and also in *Pholas truncata*, which are to be found buried along the edges of salt marshes, the burrow is seen to be surrounded by so dense a feltwork of roots from the marsh vegetation that it would seem entirely impossible that the adult animal could remove itself. It is a mystery how the young could ever force its way into such material.

FIXATION IN THE BURROW.

A peculiar habit, the utility of which is very evident, is the spinning of the byssus by the small clam as soon as it has succeeded in covering itself in the sand. As has just been stated, the small individuals bury themselves, and again appear upon the surface, and this is repeated several times. But whenever the creature goes into the sand, it apparently at once proceeds to pour out the secretion which forms the byssus thread, and attaches itself more or less firmly by this means. Figure 3 represents a clam with a shell $2\frac{3}{10}$ millimeters long which has been removed from its burrow. The single byssus thread (b) is seen to branch, the ends of the branches being attached to three sand grains (s. g.). Actually the number of sand grains and pebbles to which attachment is made is usually greater than represented. The extremity of the thread which is fastened to the foreign body is considerably widened, as shown in the figure. The character of the thread is the same, whether the creature is attached to several sand grains, or to a single filament of *Enteromorpha* or to other bodies. Figure 2 represents a very small individual, $\frac{4}{10}$ of a millimeter in length (drawn on a larger scale than Figure 3), which was attached by several branches of the byssus to one short seaweed filament.

In coming out of the burrow and moving to a new locality, the byssus is cast off at the gland in the foot and left behind, and a new one is constructed at the next descent. This is accomplished in the space of a few minutes. Clams, from the smallest which are able to cover themselves in the sand, to those at least 13 millimeters in length, exhibit this peculiar habit of forming a byssus in the burrow. How much longer the byssal organ remains in functional activity, and when it begins to atrophy, I have not determined.

The utility of this habit is well illustrated in a circumstance which recently came under my observation at the house-boat laboratory, in the Kickemuit Narrows, belonging to the Rhode Island Fish Commission. I had suspended in the water a box filled with sand which I had taken from a neighboring clam bed. In the sand I had sunken some glass dishes, about three inches in depth, and had filled these also with sand. Here I had allowed a number of small clams to burrow. On the 5th of August, the region was visited by a terrific wind storm, and everything connected with the house-boat was pitched about furiously for more than an hour. Upon examining the glass dishes afterward, I found that all the finer sand had been washed out of them, and but a few small pebbles remained. On these, however, several clams remained firmly attached, and this had prevented their being washed away. Where the waves were breaking on the beach, the same thing was probably happening. Small clams near the surface in their shallow burrows were probably washed out in great numbers. Many of them were then thrown up perhaps, and left to perish. I have been informed by clam diggers that during violent storms, when the tide is high, vast numbers of small clams are sometimes thrown up on the beach, and left high and dry to perish by the retreating tide. But while, under such conditions, many meet destruction, the possession of a byssus which is attached to pebbles and sand grains many times heavier than the clam itself must be of immense advantage in tending to keep the animal from floating off from the bottom.

THE BYSSUS THREAD.

Reference has been made to the relatively large, plowshare shaped foot which extends backward over the ventral side of the visceral mass. The byssus organ, in which the secretion for the thread is produced, is located in the usual position on the ventral side of the foot, and far toward its posterior extremity. Its position is indicated in Figures 2 and 3, in which, however, the foot is represented as being projected forward to a considerable extent, carrying the byssus organ outside the shell. The byssus itself appears to be made of a single delicate transparent thread (b) sometimes bearing a number of side branches, the end of each branch forming a point of attachment. I have not had the time at my disposal to determine the manner in which attachment is actually accomplished, but it does not seem probable that it is effected exactly as in *Mytilus* (mussel) and the young *Pecten* (scollop), in which forms a groove on the ventral side of the foot leads from the opening of the byssus organ out nearly to the tip. This groove is converted into a closed tube, and the fluid secretion of the gland is poured out into it. At the tip of the foot it is allowed to come in contact with the body to which attachment is to be made, and adheres tightly. The groove of the foot is now slowly opened, and the secretion, upon coming in contact with the water, is converted into a tough fibre. *Mytilus* forms a number of threads in this way, which extend out in various directions, and all unite near the opening of the byssus gland.

In the clam, an attachment having been made at a few points, the thread may be greatly elongated by pouring the secretion out directly into the water where it at once hardens, much as the secretion from the spinning gland of a spider hardens, after its extension, by coming in contact with the air. By fastening a byssus thread from a clam 6 millimeters (nearly ¼ of an inch) in length to the point of a needle, I have been able, by exerting a gentle pull on the thread, to draw it out to a length of 5 centimeters (about 2 inches) in the space of about fifteen minutes. The secretion was poured out at intervals, but not at any time with much rapidity. The thread thus obtained appeared to be single, was very elastic, and was possessed of some degree of toughness.

POINTS BEARING ON THE DEVELOPMENT OF METHODS OF CLAM CULTURE.

The falling off in the supply of clams in Rhode Island has for some time been regarded with serious concern, and it is still rapidly diminishing. Clam diggers everywhere on Narragansett Bay whom I have met during the present summer (1898) have given the most discouraging reports. In some localities, where clams were abundant four or five year ago, almost none can now be attained. The culture of oysters as carried on in Narragansett Bay, Long Island Sound, and elsewhere on the New England coast, has been attended by many great and serious difficulties, and yet it has become, in the hands of enterprising men, a very profitable business. In localities where it has been impossible to obtain a set of "spat," where the beaches between tide marks may not be used, where an annual rental of $10.00 an acre must be paid, where the deadly starfish abounds, and where oysters are purchased abroad and shipped great distances simply to be spread upon the bottom and allowed to grow to a marketable size, the business pays and is thriving. One or two abortive attempts have been made to develop methods of clam culture in this country, but for one reason or another—principally because of a lack of protection by law from the depredations of clam diggers—they have been discontinued. From the account of the life-history of the long necked clam given above, it would appear that it may be possible to develop culture methods which should be productive of much greater results than those obtained by oyster culture. Two or three points, brought out in the above account, as well as some facts not yet mentioned, may well be noticed as bearing on the solution of this economic problem.

(a) *The habit of attachment.*

Probably in many localities it would be possible, as it is in the Kickemuit "River," to obtain great numbers of young clams in the early summer, by simply gathering the floating seaweed to which they are attached, and transporting them to localities where the conditions should be most favorable for their further development.

Though I have no facts bearing on this point, it may be possible to bring about an artificial fertilization of the ova of the clam in such a way that the swimming larvæ might be induced to attach to some suitable object, which should be convenient to handle, when it is suspended in the water containing the embryos. This has been accomplished with some degree of success in the oyster, where artificial fertilization may be brought about with very great ease. There are some lamellibranchs, however, in which it seems to be absolutely impossible to induce this union of the sexual cells, and this may be the case with the clam. Even if it were so, sexually mature individuals might be placed in enclosed localities, where large numbers of the young could be collected.

(b) *Tenacity of life.*

While the adult *Mya* dies easily in aquaria, if not occasionally allowed to lie exposed, or if the water becomes foul, the small clams are very tenacious of life. Early in July, 1898, a bucket full of *Enteromorpha*, covered with clams, was taken from the water at the Kickemuit Narrows at eleven o'clock in the forenoon of a hot day. This was carried to Woods Hole, Massachusetts, arriving at four in the afternoon, the water in the bucket having become very warm. These clams were transferred directly to the much colder sea water in the hatching house of the U. S. Fish Commission station. None of them seemed to be in the least injured by their rough treatment, and they lived in very slowly running water for over a month, when they were removed. In this case, no care having been taken to make the conditions favorable, they did not seem to thrive, and certain individuals, measured from time to time, showed little, or in some cases, no growth. However, some of these individuals, after remaining a month in the hatching house, were placed in small glass dishes which were allowed to stand until the water had nearly evaporated, and a zooglea mass had formed on top of it, and they remained alive under these conditions for many days. These facts seem to indicate that the small clams are very hardy, and, if desirable in culture work, could easily be transported without injury.

(c) *Effect of waters of differing degrees of salinity.*

In the transfer of clams just mentioned, it may be noticed that the salinity of the water in the two localities is somewhat different. In the Kickemuit the average salinity is about 1.019; at Woods Hole, about 1.024. As is the case with oysters, clams will live in water which is brackish. At the salt pond near Wakefield, R. I., for instance, the salinity I am informed by Dr. G. W. Field is from 1.0049 to 1.0058 on the surface, and quite a number of clams are to be found along its shores; the density at the bottom may be much greater than at the surface, however.

(d) *Enemies.*

One important fact which must be considered in developing any method of clam culture is that the clam in its attached condition, and when exposed on the surface of a bed, is destroyed in vast numbers in many localities by one or two natural enemies. The worst of these is that curse of the oyster culturist in northern waters—the starfish. Many extremely interesting and important observations in regard to this creature's habits of destroying clams and other forms have been made during the past summer by Dr. A. D. Mead. These observations show that the starfish, even when minute in size, is terribly destructive to the young clams.

Another enemy of the young clam is the oyster drill (*Urosalpinx*). I have taken many clam shells from the surface sand of the bottoms, which exhibited the clam perforation filed by this creature. Shells so pierced were from 3 millimeters to 2 centimeters or more in length. As I have never found drilled shells in any great numbers in one locality, it would appear that the clam is not seriously menaced by this foe. The adult clam, deep below the surface, is probably not disturbed by other enemies than man.

SUMMARY.

To recapitulate the principal points established in the above description of the life-history of the clam, beginning after the swimming larval condition: The breeding season in Narragansett and Buzzards Bay probably extends through May and June into July. Beginning my observations late in June, I have not been able to determine its limits with any certainty. After the free swimming larval period, the young clams attach themselves by means of a byssus, which is produced from a byssus gland in the foot. Attachment is made to various bodies in the water, but chiefly to the filaments of *Enteromorpha*, a green seaweed growing near the shores. Clams may be found so attached from the latter part of June to the first of August. They are to be found in certain localities in immense numbers. The attached individuals measured varied in length from $\frac{4}{10}$ millimeter to 7 millimeters. The shape of the smaller individuals differs greatly from that of the adult in being much more rounded, with umbones widely separated laterally. As they become older, they gradually assume the outline which characterizes the adult, but in so doing the umbones come to be situated relatively far forward and then again move back toward the middle of the shell on the dorsal side. This shifting in the relatative position of the umbo is due to a more rapid growth of the posterior, and subsequently of the anterior ends of the shell.

In the smallest forms examined, the mantle folds were in concrescence ventrally. The foot is relatively greatly developed, extending over the entire ventral side of the visceral mass. The siphons have the general characters of those in the adult, but they are filmy, and may be retracted within the shell with very great quickness.

Clams of all sizes are apparently freeing themselves from their attachment on the weed. The byssus is cast off, and the creature climbs about from one filament to another by means of the foot, sometimes reattaching, sometimes falling free from the weed to the bottom. In the sand, unless it be excessively fine, individuals less than 2 millimeters in length are rarely able to cover themselves, though they always make the attempt. Those 5 or 6 millimeters long are apparently able to burrow beneath the surface of any clam shore.

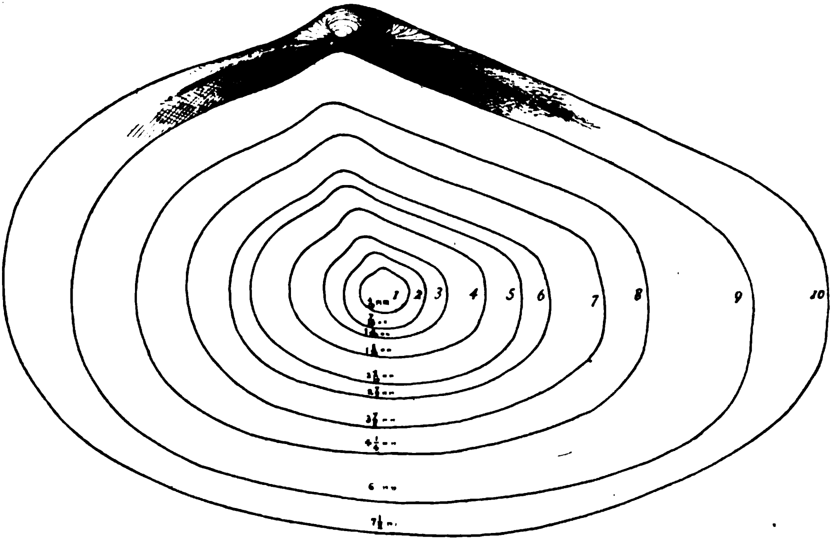

Fig. 1

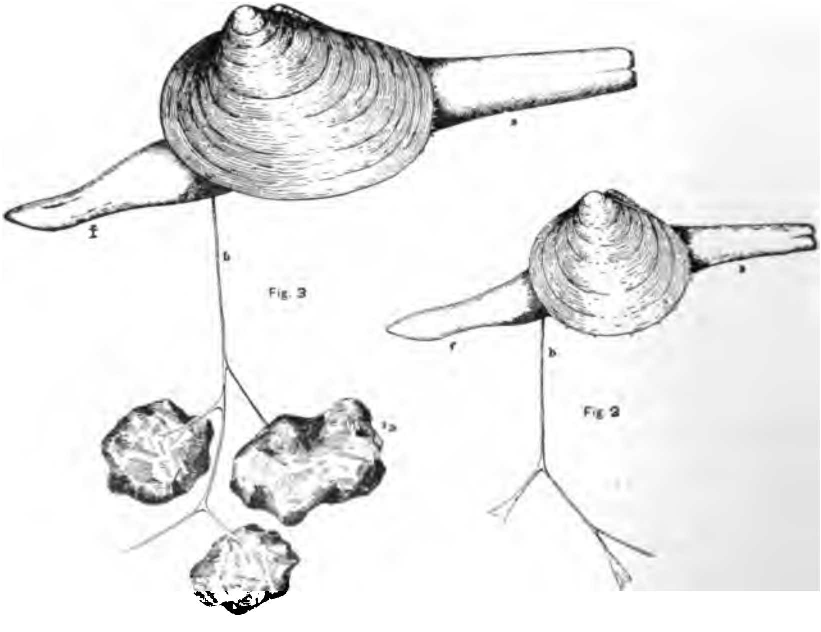

Fig. 3

Fig. 2

Having attained a lodgment in the sand, all clams observed at once proceed to form a byssus thread, which is attached to sand grains and pebbles. This tends to secure the creature, so that, even if water currents or the action of the waves should dislodge it from its burrow, it would not be carried so far from its original position as would otherwise occur.

Of their own accord these clams frequently leave the first burrow, wander about, and form another, some individuals repeating the process many times. A time finally comes when they dig into the sand to remain permanently.

DESCRIPTION OF FIGURES.

FIGURE 1. *Mya arenaria.* Ten camera outlines of shells varying in length from $\frac{4}{10}$ of a millimeter to 7½ millimeters. They are intended to illustrate the change from a rounded outline in the smaller individuals to the elongated condition of older forms. In this there is at first a more rapid posterior, and subsequently a more rapid anterior, growth of the shell, which causes the relative position of the umbo to shift forward, and then back to a position midway between the two extremities of the shell.

FIGURE 2. *Mya arenaria.* An individual with shell $\frac{4}{10}$ of a millimeter in length. Removed from attachment to seaweed (*Enteromorpha*) and showing the single, branched byssus thread (b) arising from a byssus gland at the base of the foot (f). The filmy siphons (s) are shown protracted.

FIGURE 3. *Mya arenaria.* Form $2\frac{3}{10}$ millimeters long (drawn on smaller scale than Figure 2), removed from burrow in sand, and showing attachment of byssus (b) to numerous sand grains (s. g.).

X. *The preparation of a relief map of Narragansett Bay.*

It is self-evident that a thorough knowledge of the habits and distribution of fish in the waters of the Bay requires a knowledge of the territory itself, and particularly of the configuration of the floor of the Bay and of the sedimentary deposits. The Commission, therefore, has prepared a large relief map, which gives an excellent idea of the distribution of fresh, brackish, and sea water, and enables one to determine at a glance the location of the fish traps, their relation to the channels, and the various shallow water tracts already available or adapted to successful clam and oyster culture.

XI. *An examination of the feasibility and practicability of artificial lobster culture.*

That the lobster industry of Rhode Island is rapidly waning needs no argument. The incessant unrestricted capture of the adults and young, the annual destruction of many millions of eggs by indifferent fishermen, and the inroads made upon the native supply by those not inhabitants of the State, have so reduced the annual catch that the industry is no longer profitable, and the lobsters themselves are sold at prices that make them prohibitive to many as a regular article of food.

The artificial hatching of the lobsters' eggs is an extremely simple matter, and has been carried on for many years in Norway, New Foundland, Gloucester, and Woods Hole; but the young (Plate A, Fig. 1) when liberated are in no condition to care for themselves. They swim or float about in the ocean, their bright colors rendering them attractive to predatory fishes. Currents carry them far from their native grounds, and it is probably safe to say that scarcely one in a thousand finally reaches a matured condition. It is evident then that the mere planting of lobster fry, can have little, if any, effect towards rehabilitating the lobster industry.

The helpless lobster fry swim about in the water for a period of about four weeks, during which they pass through the stages represented in Figs. 1, 2, 3, before settling to the bottom to assume the shape and retiring habits of the adult (Plate B, Fig. 4). If it were possible to carry the young lobster through this free-swimming period of their youth, there is every reason to believe that the young so reared would, on liberation, seek hiding places in the crevices of rocks, under shells, etc., and the period of greatest mortality would thus be overcome.

Efforts repeatedly have been made to brood the young, but the animals are so delicate, and at the same time so voracious, that it is extremely difficult to keep them alive in any of the more ordinary forms of hatching apparatus. One of the Commissioners, during the past spring, prepared several large "fish-cars" (about sixteen feet in length, six feet in width, and five feet in height), with fine wire mesh, the holes of which were sufficiently large to enable many small animals to enter as food, but so small that the young lobsters could not escape. The bottoms of some of these cars were covered with gravel and pieces of growing seaweed, and everything was done that could be done to make a natural environment.

The experiment, so far as the young lobsters were concerned, was a failure. The young of rapidly growing predatory animals worked themselves into the car and preyed upon the helpless larvæ. The sea water, laden with dirt and sediment, on reaching the more quiet water of the interior of the car, simply precipitated its refuse and left a quantity of decaying organic matter to poison the water.

The next experiment consisted in the placing of a large cheesecloth cage inside of one of the fish-cars. The mesh of the car thus protected the finer mesh of the cheese-cloth frame, but the young lobsters did not flourish. There was not sufficient motion to the water to keep them floating; their feet became entangled in the fibres of the cloth, and they preyed sadly upon each other.

The breeding season of the lobster is not sufficiently extended to enable one to experiment along a large number of lines, but before the close of the season the results obtained were more encouraging. Several lobsters were actually raised to that stage when the characters of the adult are assumed—the fourth molt, Figure 4. These young lobsters were raised in a car of somewhat novel design, but so arranged that the water after flowing into the car has a considerable amount of motion. The fry were fed upon shreded codfish, which contains a sufficient amount of air to cause it to descend only slowly through the water, and it thus becomes an attractive object to the young animals, which quickly follow any moving object. At times minute pieces of fresh fish were greedily devoured, and the writer has repeatedly seen the young animals follow the scent, which has been left in the sea water by a piece of slowly descending fish, until several pounced upon the object when it finally reached the bottom of the aquarium.

The results of the season's experiments are such as to warrant a continuation of the work. We know perfectly well that many others have failed in doing what we attempt, but until we are thoroughly convinced that the young lobster cannot be "brooded," we propose to continue our work.

XII. *The extension of the commercial fisheries of the State through the discovery of new localities for food fish.*

The extension of the commercial fisheries of the State through the discovery of new localities for food fish at first impression would appear absurd in a locality so well known as are the waters of Rhode Island, but only a short distance to the south (a distance that can readily be covered by an ordinary sailing vessel in a single night) are the warm waters of the Gulf Stream, and a member of the State Commission has conducted several expeditions, in the United States Fish Commission Schooner "Grampus," to the edge of the continental plateau, for the purpose of determining the presence of a valuable food fish discovered there some years ago, but since supposed to have become extinct. These

Plate A.

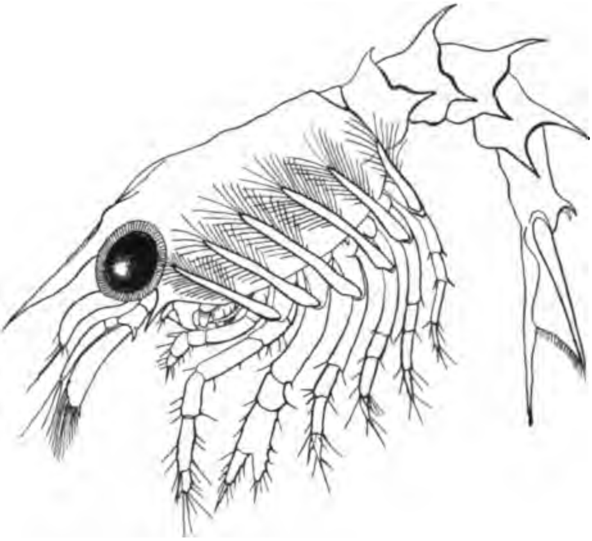

Fig. 1. Larval lobster at time of hatching—enlarged fifteen times.

(*From F. H. Herrick*).

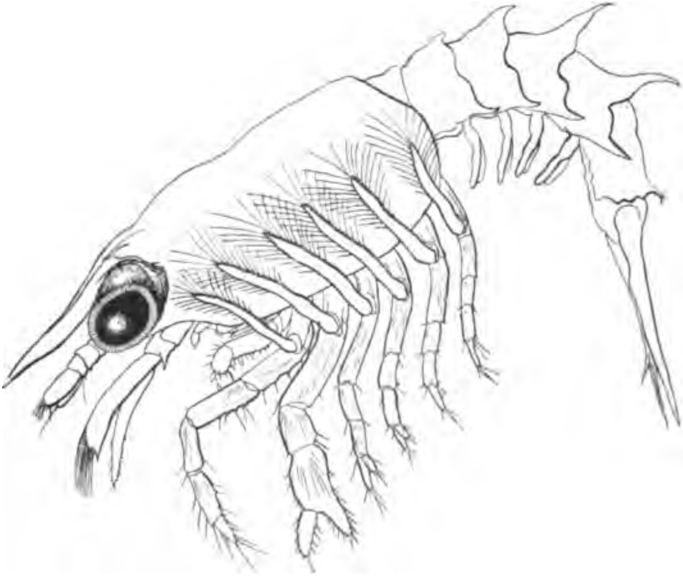

Fig. 2. Larval lobster after first molt—enlarged fifteen times.

(*From F. H. Herrick*).

Plate B.

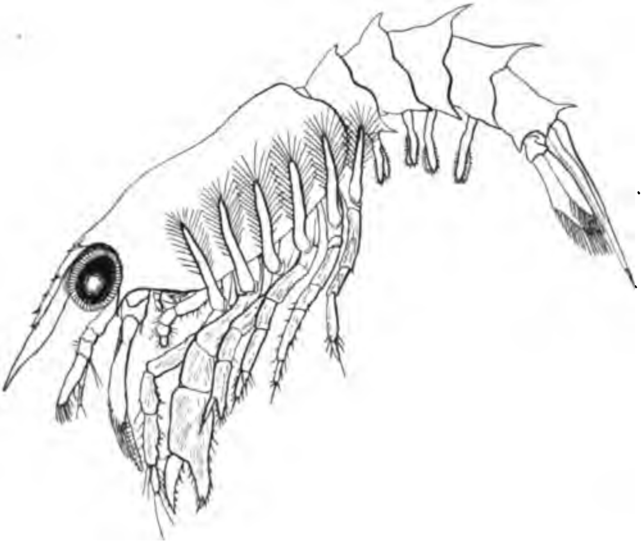

Fig. 3. Larval lobster after second molt—enlarged eleven times.

(*From F. H. Herrick*).

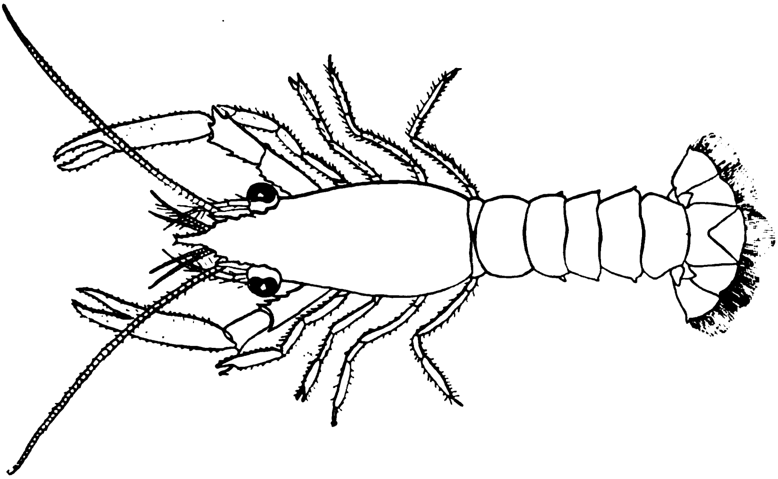

Fig. 4. Young lobster after third molt—enlarged five times.

(*From F. H. Herrick*).

expeditions have resulted in the capture of large numbers of tile-fish, and the definite location of a fishing ground which may develop an industry of great importance. The exact location of this tile-fish ground is indicated on an accompanying chart.

As is well known, a cold Arctic current flows westward between our coast and the Gulf Stream, and it is in this colder and shallow water that the cod and haddock fisheries are largely carried on. The Gulf Stream as it approaches the north is deflected from our shores by this Arctic current, and its deeper waters are also deflected by the steep bank of the continental plateau. The bottom in this neighborhood drops off very rapidly to a great depth, where the water becomes excessively cold. There is thus left on the upper edge of this bank a band of water, brought by the Gulf Stream from the south, which is both very much warmer than the shallow water lying immediately on the north and the deeper water lying on the south. It is in this narrow band of the sea bottom that the tile-fish, a tropical animal, finds an abundance of food, and it occurs in great numbers.

The following is a brief history of a fish which promises to become of great economic importance to our State.

ON THE REAPPEARANCE OF THE TILE-FISH.*

(*Lopholatilus chamæleonticeps.*)

During March and April, 1882, the presence on the surface of the ocean of large numbers of dead tile-fish gave rise to considerable discussion in scientific journals, and frequent allusions have since been made in text-books, and elsewhere, to this phenomenon as illustrating the elimination of a species in recent times by purely natural agents. The reappearance of the fish in abundance in its original locality is, therefore, of considerable biological interest.

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* [*Reprinted from* SCIENCE, *N. S., Vol. VIII, No. 200, Pages 576-578, October 28, 1898.*]

The history of the discovery, the "extinction" and reappearance is as follows:

In May, 1879, Captain Kirby, of Gloucester, caught a great number of tile-fish off the southern coast of Nantucket, in water about 150 fathoms in depth. Specimens were sent to Washington, and the species was described by Goode and Bean in the "Proceedings of the U. S. National Museum" for that year. In July, Captain Dempsey, also of Gloucester, found several specimens in practically the same locality.

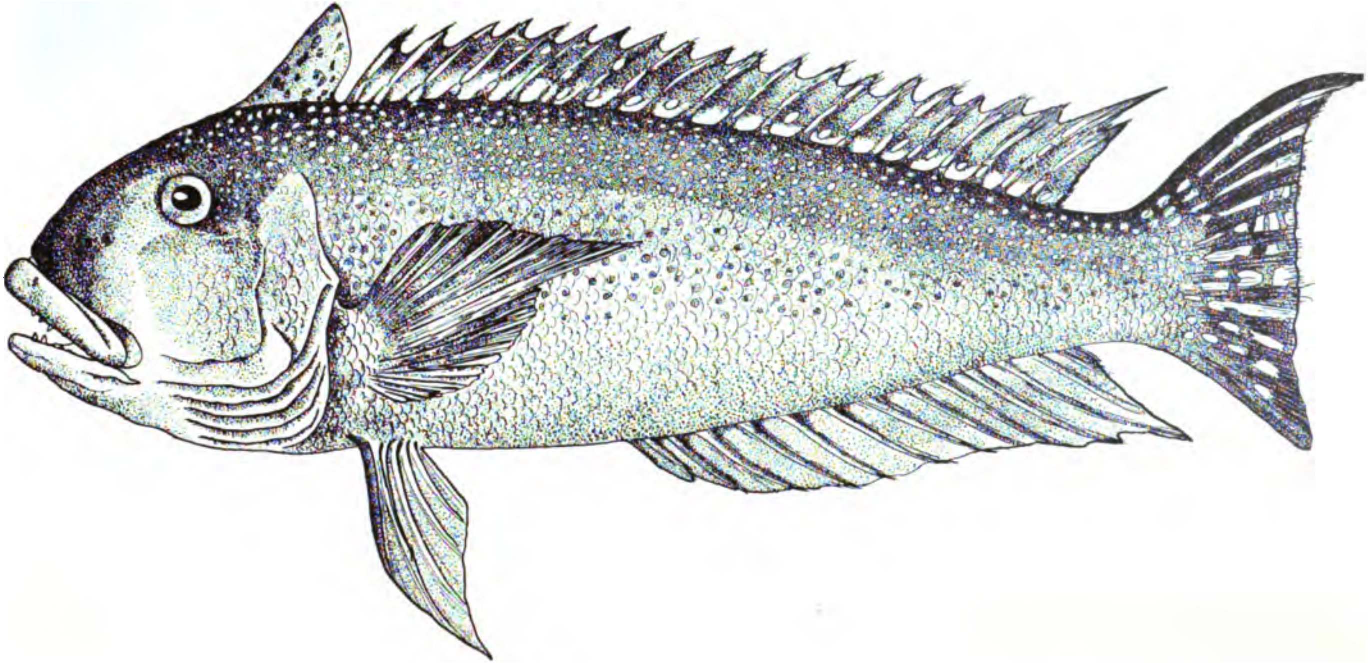
In 1880 Professor Baird sent the "Mary Potter" to search for the fish, but the expedition, on account of uncommonly severe weather, was not successful. The "Fish Hawk," however, while exploring along the continental plateau, caught several specimens.

In 1881 the "Fish Hawk," continuing deep-sea work along the southern shore of New England, caught a large number, and Professor Baird felt confident that he was about to establish a new industry.

In March and April, 1882, vessels entering New York and other Atlantic ports reported that they had passed through countless numbers of dead fish while crossing the northern edge of the Gulf Stream. Investigation proved that these were tile-fish, and that they appeared on the surface of the water for an extent of 170 miles in length and 25 miles in width. A conservative estimate, made by Captain J. W. Collins, placed their number at upwards of 1,438,720,000. Allowing ten pounds to each fish, there would be 288 pounds of fish for every man, woman, and child then in the United States. In September, Professor Baird chartered the "Josie Reeves" and sent her to the tile-fish grounds, that he might ascertain to what extent the species had been depleted; but the vessel returned without having found a single individual.

In 1883 the "Albatross" made further search, but without success.

In 1884 the "Albatross" made a more careful investigation, but again without success.



Tile-fish. (*Lopholatilus chamæleonticeps*).

In 1885 the same vessel searched from Newfoundland to the Gulf of Mexico without discovering the least trace of the tile-fish, though *Munida*, a species of crustacean upon which the fish was known to have fed, was found in abundance.

In 1886, 1887, 1888, 1889, 1890, and 1891 nothing new was learned.

In 1892, at the suggestion of Professor Wm. Libby, Commissioner McDonald fitted out the "Grampus," and on August 5th trawls were set on the old tile-fish ground. No fish were taken. On the 6th the trawls were set again, and one specimen, weighing seven pounds, was brought to the surface. This was the first specimen that had been seen since the mortality of 1882, ten years before. The "Grampus" continued her work, and in about two weeks caught a second specimen, which weighed thirteen pounds. On September 17th one specimen was caught, and on September 18th three specimens were taken. No more were caught until October 8th, when two were found off the Delaware coast. Thus, in 1892, a search of two months yielded only eight specimens.

In 1893 the "Grampus" resumed the search throughout the months of July, August, and September and caught scattering specimens.

During 1884, 1895, and 1896 no additional information relative to the fish was secured.

On February 8, 1897, the Schooner "Mabel Kenniston," of Gloucester, was overtaken by a gale on George's Bank and blown 120 miles toward the southwest. After the gale, trawls were set in sixty-five fathoms of water, and thirty tile-fish were caught. These weighed from six to fifteen pounds each. They were landed at Gloucester on February 16th.

On August 12th, of the present year, the "Grampus" left Woods Holl with a small party of scientific men, and sailed to a point about seventy miles south of No Man's Land. At the first set of the trawl, eight beautiful tile-fish were taken. The boat, insufficiently equipped with lines and bait, at once returned to the "station." New trawls were purchased and on August 30th, ice and bait having been taken on at Newport, she again sailed south. The following morning, when the boat was only sixty miles from Block Island, the trawls were set. The first haul yielded seven fish; the second, forty-seven, and the third, nineteen. On the following day seventy-eight fish were taken, many of them of large size, and the vessel, now bearing 1,000 pounds, headed for Montauk Point, where the fish were given to the soldiers at Camp Wikoff.

When one considers that the trawls were short, provided with only a few hooks and tended by only one dory, it would seem that the fish are sufficiently abundant for an ordinarily equipped fishing-smack, with its miles of trawls, to secure a full fare in a very short time.

The tile-fish, since the mortality of 1882, has been taken only along the edge of the continental plateau, in water near the one-hundred fathom line, from points south of No Man's Land, Block Island and the eastern portion of Long Island. The "range" of the species, as at present determined, is restricted to a tract of the sea bottom about one hundred and fifty miles in length, and ten to fifteen miles in width. The "stations," however, are few, and further investigation may result in a considerable extension of the range. The fish that have been caught during the past summer differ in respect to size from those that were caught before the mortality; for, while many are large, weighing fully twenty pounds, there are also many small immature individuals which often weigh but a pound or two. This percentage of immature fish would seem to indicate that the present environmental conditions are favorable, and that the species has become re-established.

H. C. BUMPUS,

Director of Biological Laboratory.

U. S. F. C. STATION, WOODS HOLL.

NOTE.—The "Grampus" again visited the tile-fish grounds the latter part of September, returning to Woods Holl on October 2, with over two hundred fish, weighing upwards of 3,000 pounds. This last catch was made between the meridians of 69 and 70, a

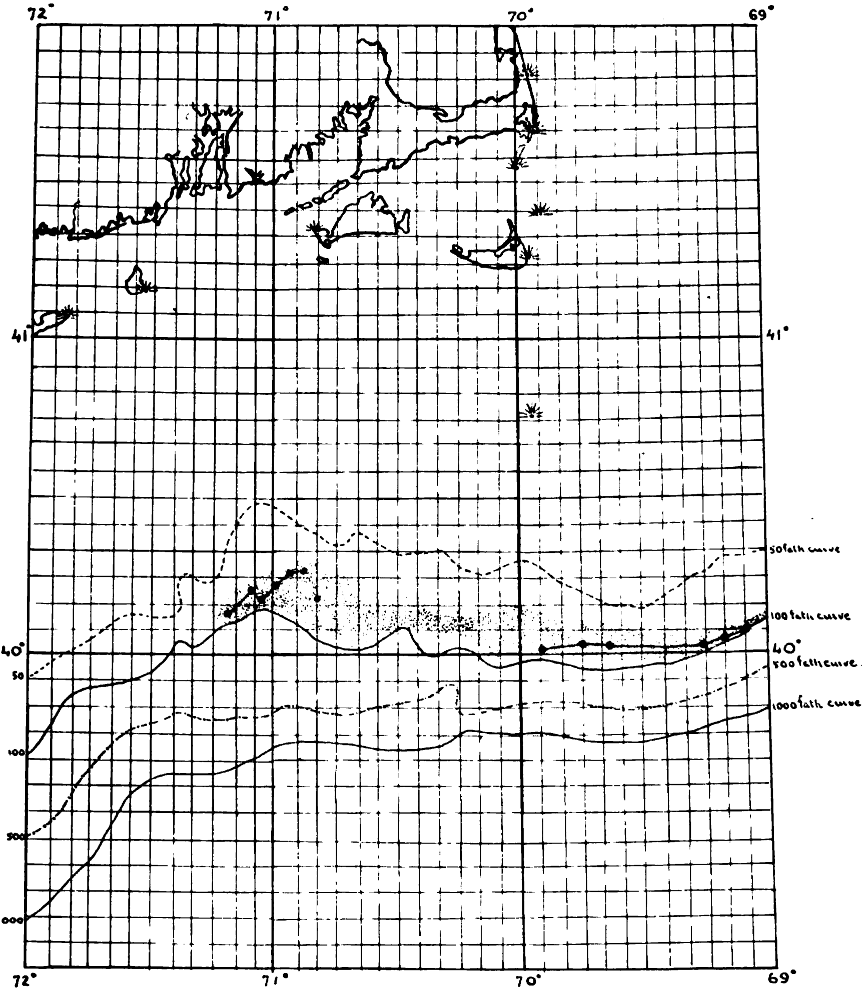


Chart showing the location of the tile-fish grounds. The stations at which tile-fish were actually taken are represented by heavy black dots connected with lines. The area of the sea bottom that is probably inhabited by the tile-fish is stippled.

tract that has not heretofore been known to be occupied by the fish, and indicates an eastern extension of the range of about twenty-five miles.—H. C. B.

XIII. *Improvements in the methods of preparing fish for shipment.*

The value of the fish caught along the shores of the State does not alone lie in their use as food by people residing within the limits of Rhode Island, but their exportation brings a large income to those interested in the industry.

A most casual examination of the methods of packing and shipping fish, when compared with the methods of packing and shipping poultry, meat, etc., will show that, whereas the methods of shipping the latter have materially improved within the last few years, the packing and shipping of fish is at the present time both crude and wasteful. The ice is in itself expensive; it occupies room that might be used for other purposes; its weight gives rise to excessive express charges; and when melted the fish are soaked in the impure fluid, and rendered unpleasant to handle, uninviting to witness, and subject to rapid decay.

Your Commission therefore has thought it advisable to examine more carefully into the present methods of packing and shipping fish, with the purpose of devising, if possible, some means which will eliminate many of the present unpleasant features. Mr. Ralph W. Tower was engaged to do this work, and his report is as follows:

SPECIAL REPORT

ON

METHODS OF PREPARING FISH FOR MARKET.

BY PROFESSOR RALPH W. TOWER.

It is a well known fact that ice, as it is used in the ordinary methods of fish packing, is more or less of a failure. It spoils the freshness, flavor, and firmness of the fish; but, more than this, the moisture of the melting ice favors the development of putrefactive bacteria and hastens decay. The investigations which I have made at the suggestion of the Commission have been planned for the purpose of ascertaining just how far fish are spoiled by carelessness, filth, and bad packing, and to devise methods of mitigating these evils.

Decay is nothing but the result of the activities of certain putrefactive bacteria. If the fish are so handled that the activity of the bacteria is restricted, the process of decay will be retarded; but if the fish are handled in such a way as to encourage the ravages of the bacteria, the process of decay will progress much more rapidly. The pressing of fish by close packing softens the muscles and renders the flesh more susceptible to invasion by putrefactive bacteria. Another item of no small importance is the packing of fish in foul barrels and unclean boxes, the contamination from which is conveyed to the several fish by the melting ice.

The animals used for the following experiments were squeteague, bonito, bluefish, and tile-fish. The fish taken from the traps of the United States Fish Commission furnished an unlimited supply of material. During the months of July and August, the most abundant fish were squeteague. The flesh of these fish is soft, very susceptible to invasion by putrefactive bacteria, and difficult to preserve by the ordinary methods of packing. The flesh of the bonito is firm and hard, and is much easier to preserve.

I. The first experiments were made with squeteague, with a view to determining the influence of ordinary summer temperatures, and of different methods of killing and handling, upon putrefaction. Forty-eight fish were hung up, by a wire passing through the eyes. Twenty-four had the intestines removed, and the fish were drained immediately after capture. The remaining twenty-four were not opened. The experiment was made in a place that was protected from the sun, but to which the air had free access. The weather was humid and foggy, the temperature being 68° at 8 A. M., 72° at M., and 71° at 5 P. M. After remaining twenty-four hours, the fish were examined: those which were unopened were putrid and emitted an almost unbearable odor. The fish whose intestines had been removed were in a better condition, and the abdominal cavity was much fresher. Putrefaction had not penetrated so deeply into the flesh, and these fish might even have been used for food. The experiment shows that when the intestines are not removed decomposition takes place much more rapidly, and that the immediate removal of the viscera delays decomposition.

II. The next experiment was made with twenty-four squeteague and six bonitos. After the removal of the intestines as above the fish were laid on their sides, but not in contact with one another. The day was humid and foggy, the temperature ranging from 69° at 8 A. M., and 72° at 12 M., to 71° at 5 P. M. At the end of twenty-four hours the fish were examined. The squeteague were badly decomposed on the side next the wood. On the other side decomposition had not proceeded so far, although it had progressed to a considerable extent. In the body cavity decomposition was evident, but it had not advanced very far. The bonitos were in much better condition, although an odor of putrefaction was noticeable, and the side on which they lay was most affected. The walls of the body cavity were also in better condition than those of the squeteague. The experiment showed that free circulation of air around fish retards decay.

III. After the intestines had been removed from twelve squeteague, the fish were hung up by their tails, and allowed to remain twenty-four hours. The weather was cloudy, and the temperatures were as follows: 8 A. M., 71°; 12 M., 74°; and 5 P. M., 73°. The atmospheric conditions were less favorable for the preservation of fish than on the previous day, yet at the end of twenty-four hours the fish were found to be in much better condition than in any of the preceding experiments. There was a decided odor of putrefaction on the outside of the fish, but the abdominal cavity and the muscles showed only a little evidence of decomposition. The fish were in as good condition as many fish found in our markets and generally sold as "fresh." The experiment shows that early cleaning, thorough draining, and free circulation of air retard putrefactive processes.

IV. Twenty-four living squeteague were decapitated, and their intestines removed. The intestines were removed from another series of equal number, but these animals were not decapitated. The forty-eight fish were then packed in a box, in close contact with one another. The weather and temperature conditions were practically the same as on the preceding day. At the end of twenty-four hours, the fish were examined. They were very soft and had a bad odor, although those which had been decapitated were in a better state of preservation than the others; all were unfit for use. The fish on the top layer, where they were exposed to the air, were in early, while those at the bottom, away from the air, and moistened by the drip from those above, were in advanced, stages of decomposition.—The experiment indicates the importance of thorough drainage of the flesh by early decapitation.

In all the above experiments the fish were taken from the fish-trap alive, and were immediately prepared to meet the conditions of the various experiments. By this means no decomposition could have taken place before the experiments were begun. The fish were handled *as carefully as practicable,* so as to prevent bruising or rupture of the muscular tissue. Cleanliness was assured through copious washing with sea water.

To recapitulate, the experiments show that putrefaction takes place most rapidly in fish from which the intestines have not been removed; that moisture augments the process of decay. Free access of air tends to arrest, rather than promote, putrefaction, and drainage of the blood system is an important means of preventing decay. If the head and intestines are both removed, and the fish is suspended by the tail so that the blood, which is a most favorable medium for the growth of putrefactive bacteria, is drained from the entire body, the fish will remain sweet for a considerable time without the use of ice.

In none of the above preparations were putrefactive bacteria *prevented from entering the flesh,* or hindered in their action after entrance. Consequently further investigations were made to attempt to dress and pack the fish in such a manner that the bacterial invasion could be *delayed* at least for a few hours. To do this the fish were *washed* with a solution which would be unfavorable to the growth of bacteria, and at the same time not in any way injurious to the flesh. It is to be noted, however, that the fish are not injected with the solution, nor are they in any sense preserved in it.

Various solutions were tried, and, with one exception, without success. In every case the control experiments were made on fish taken at the same time, but not subjected to special treatment:

I. The first experiment was with a 0.1 per cent. solution of salicylic acid in sea water. Twenty-four squeteague, taken alive from the nets, were carefully dressed, washed with this solution, packed in a box, and allowed to remain for twenty-four hours. The temperature ranged from 73° to 76°. When examined the next morning, there was a perceptible odor of putrefaction; the fish were soft and unfit for market. The control fish were not much worse. Experiments were subsequently made with the same solution, but none was successful.

II. The next preparation experimented with was a 10 per cent. solution of potassium nitrate. Eighteen squeteague, cleaned immediately after being taken from the nets, were decapitated and thoroughly washed with this solution, and packed close together in a box. During the next twenty-four hours the weather was foggy, and the temperature ranged from 73° to 74°, at the end of which time decomposition had advanced to such a stage that the fish were totally unfit for market. There was no appreciable difference between the fish subjected to the potassium nitrate and those of the control experiment. Six more trials were made with this solution, but always with the same results.

III. A 5 per cent. solution of formalin was next used, but, as might have been predicted, the fish did not keep, and they were as bad at the end of twenty-four hours as those of the control.

IV. The next, and most successful, experiment was made with a 3 per cent. solution of boric acid ($B_2 O_3$) in sea water. Two dozen squeteague were dressed immediately after being caught. Some were decapitated, and others were packed with head and gills attached. All were then *merely washed* in the above solution, and then closely packed in a box. The weather was foggy and cloudy. The temperature ranged from 74° to 83°. When examined, twenty-four hours later, the fish were found to have kept well. There was no odor, and decomposition had evidently not begun. The flesh was hard and firm, the eyes were clear, and in fact one of the fish was declared, by a native fisherman, to have been taken from the water that very morning, and he was not readily convinced that it had been kept without ice for twenty-four hours. One of these squeteague was baked and served on my own table, and was pronounced excellent. It is needless to say that the control fish were in advanced stages of putrefaction, and wholly unsuitable for food.

In these experiments with boracic acid, the fish were in no sense "embalmed," or even preserved. The walls of the adominal cavity, after the removal of the viscera, were simply washed with a sponge that had been dipped in the solution. The success of the experiment is of course largely dependent upon the *immediate removal* of the viscera after the capture of the fish; the *careful handling* of the fish, both before and after evisceration; the thoroughness with which the walls of the abdomen are washed; and the care with which the fish are packed. The use of boric acid will not prove satisfactory if fish are first thrown about, walked upon, slovenly eviscerated, washed in the sterilizing fluid, and then pitched into barrels. Those who prefer to abuse fish in this way will do well to stand by the older and more expensive methods, use ice, and complain of the market.

Mr. Eugene G. Blackford, one of the largest wholesale dealers in New York, has said, "As an example of the increased returns to the shippers from careful handling, I call attention to the fact that certain shipments of shad, going to the New York market from North Carolina, bring from 25 per cent. to 40 per cent. more than other shad from the same locality."

"What I wish to impress upon the shippers and fishermen is, that for every dollar invested in labor and ice in packing the fish they will receive ten dollars in return."

Twenty more experiments were made with the same solution. Some of the animals were decapitated and others were not, but the swim-bladders and kidneys were removed from all. If the gills were thoroughly washed in the solution, it was found that even fish with the head attached kept as well as those which were decapitated. Nevertheless, in fish treated with boric acid, it is in the gills that putrefaction first shows itself.

A bushel basket full of squeteague prepared in this way was put on the deck of the U. S. F. C. S. Grampus, on the morning of August 12, where they remained exposed to the sun throughout the day. The next morning, when they were cut up for bait, they showed no sign of decomposition. On another trip, a catch of tile-fish weighing 1,000 pounds was washed in the solution. The fish were then packed in ice, where they remained for two weeks. When unpacked they were in a *perfectly fresh* condition.

It is evident, then, that this solution retards the initial stages of putrefaction, even at summer temperatures, and for a sufficient time for the fish to arrive at the markets, where they may be iced and kept indefinitely. The solution of boric acid thus used is *not a preservative*, and it is not intended as such, but, like soap, is an *agent of cleanliness.* As the fish are simply sponged over, the amount of the fluid that remains on a single fish is inconsiderable, and careful analysis fails to show more than the least trace in the flesh. Moreover, Chittenden and Gies have shown that boric acid given in doses, even up to 3 gm. per day, has no effect upon proteid metabolism, or on the nutrition of the body; that it is not cumulative, but is quickly eliminated from the system; and that it produces no renal complications. Its employment, therefore, as above recommended, can have no injurious effect on the consumer.

In preventing the growth of the micro-organisms which cause putrefaction we also eliminate the cause of ptomaïne formation. Though some of the ptomaïnes are exceedingly poisonous, this is not characteristic of all, and it can be safely stated that the greater number of those that have been isolated are of a non-poisonous nature. The kind of ptomaïn that is formed depends upon the sort of micro-organism which produces it, the character of the material acted upon, and the circumstances under which putrefaction takes place. As the ptomaïnes are only transition products in the process of putrefaction—mere temporary stages in the great process of decomposition by which the complex organic molecule is transformed into the simple inorganic state—it is evident that the kind of ptomaïn present in putrid fish is dependent upon the stage of putrefaction. The ptomaïnes formed when the putrefaction takes place in free atmosphere will also be different from those resulting from putrefaction where atmosphere is excluded. At the present time almost any illness caused from infected food is generally spoken of as being due to "ptomaïn poisoning." In the majority of cases, however, the poisonous bacterial products are not basic, although their true chemical structure is not understood.

The researches of Meisener Rosenbach, G. Hauser, F. John J. von Todor, and others, have shown that the blood and flesh of healthy animals is entirely free from bacteria. But the contents of the digestive organs are rich in Schizomycetes. (Popoff has shown that the digestive canal of a healthy new-born animal is, at the moment of birth, free from bacteria. These, however, subsequently obtain access, principally in the food, and the contents of the bowels become extremely rich in microbes.)

If a slaughtered animal is left without being disemboweled, these bacteria will make their way through the capillary vessels of the intestinal villi into the arterioles, the alkaline contents of which (rich in albumen) are especially favorable to these acidly putrefactive bacteria, so that the entire carcass quickly begins to undergo decomposition. This early decay may be prevented by the immediate removal of the entire alimentary canal, from œsophagus to rectum, and, if this precaution be taken, the flesh will for a time remain free from putrefactive bacteria. If putrefaction afterwards sets in, it is due to the bacteria from external sources obtaining access to the flesh.

The gradual penetration by way of the blood vessels into the interior of the flesh has been studied by Trombetta and Gartner. Gartner found them only in the external layers of meat three days old; but at the end of seven days they had penetrated 2 c. c. below the surface. It is, however, probable that the flesh of fish is not so resistant to the penetration of bacteria. The sources of this bacterial infection cannot be entirely removed, but they can be considerably reduced by cleanly procedure, and attempts may be made to restrict the increase of the microbes and thus arrest the process of decay. The most common remedy is cold, but experiment has shown that the temperature must be kept some degrees below zero C. in order to obtain the best results. This method is used not only in the American and Australian abattoirs, but haddock caught in Norway are cleaned and frozen at 50° C, and are then shipped in specially constructed steamers. This freezing of the fish does not immediately kill the bacteria present, but prevents their reproduction for the time being. Koch has found very many bacteria in fish that have been treated in this way. Foster has found that certain germs increase in meat stored at moderately low temperatures, though actual putrefaction is not produced by them. Moreover, the researches of Frænkel, Bordoin, Uffreduzzi, Prudden, and Heyroth show us that natural ice may contain both putrefactive and pathogenic bacteria. This fact alone should teach us to look with suspicion upon any meat that has been brought in direct contact with ice, especially where the ice is allowed to melt and the drip to permeate the flesh.

It is worthy of note in this connection that poisonous ptomaïnes do not begin to appear until about the seventh day of putrefaction, and that they finally disappear, if putrefaction is allowed to go on for a considerable time. The toxicity of the ptomaïnes themselves is not affected by cooking, no matter how thorough this may be. There are two distinct kinds of poisoning that may arise from the use of fish as food. The first is an intoxication caused by the devouring of meat which has become invaded by ptomaïn-producing bacteria. The second is an intoxication brought about by fish not necessarily infected with bacteria, but in which the poisons are *leucomaïnes* produced by the tissues of the fish and their normal product, in the same way that certain toad-stools are always poisonous.

29,150

State of Rhode Island and Providence Plantations.

THIRTIETH ANNUAL REPORT

OF THE

COMMISSIONERS OF INLAND FISHERIES,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

JANUARY SESSION, 1900.

PROVIDENCE:
E. L. FREEMAN & SONS, PRINTERS TO THE STATE.
1900.

APR 2 97

State of Rhode Island and Providence Plantations.

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1900.

COMMISSIONERS OF INLAND FISHERIES OF RHODE ISLAND.

J. M. K. SOUTHWICK, *President*	Newport, R. I.
HENRY T. ROOT, *Treasurer*	Providence, R. I.
WM. P. MORTON, *Secretary*	P. O. Box 966, Providence, R. I.
CHAS. W. WILLARD	Westerly, R. I.
ADELBERT D. ROBERTS	P. O. Box 264, Woonsocket, R. I.
HERMON C. BUMPUS, Ph. D.	Brown University.

REPORT.

To the Honorable the General Assembly of the State of Rhode Island and Providence Plantations, at its January Session, 1900:

The Commissioners of Inland Fisheries herewith present their annual report for the year 1899:

The work undertaken by the commissioners during the past year, may be tabulated as follows:

First. The stocking of our ponds and streams with suitable fresh-water fish, through the distribution of eggs and fry.

Second. The collection of definite data respecting the times of arrival and departure of various food-fishes, and the preparation of statistics of exportation.

Third. A continuation of the observations on the breeding periods of native marine animals.

Fourth. The location of fish-traps within the waters of Narraganset Bay, and the collection of statistical data bearing upon their ownership.

Fifth. Observations to show the influence, if any, that trap-fishing may have upon line-fishing.

Sixth. The continued examination of the physical and biological conditions of the waters of the Bay, begun in 1898.

Seventh. Experiments to test the feasibility of clam culture.

Eighth. A preliminary survey of the shores of the Bay, for the purpose of determining those portions which in the past were productive clam beds.

Ninth. An investigation of the life-habits of the clam, its breeding period, its food, its rate of growth, its natural enemies, and experiments to test the feasibility of artificial propagation.

Tenth. Continued work on the off-shore fisheries.

Eleventh. Efforts at lobster culture.

Twelfth. Distribution of lobster fry.

Thirteenth. The preparation of a list of the fishes known to inhabit the bay.

Fourteenth. A list of the diatoms found in the water over the clam, mussel, and oyster beds.

These subjects are treated in the above order in the present report, and in view of the results thus far obtained the Commission does not hesitate to ask for a small naphtha launch, and a new floating laboratory, both of which are absolutely essential to the efficient prosecution of their work.

A great deal of time has been lost during the past year in rowing or sailing about, often against head winds and currents; and since the greater amount of shore work must be done during the few hours of low tide, it is necessary to have the means of moving rapidly from place to place. It is the plan of the Commission to purchase a launch of such size that it can be easily cared for by one man, thus making the appointment of extra help unnecessary. Such a boat can be purchased for about $900, and the expense attending its maintenance will be inconsiderable. The work of the Commission has for some years been carried on in the small floating laboratory originally designed for hatching lobsters, and located in the Kickemuit River. On this structure, which is really little more than a fish-car, there has been scant room for one worker, no means of providing heat during the cold weather, and the floats have been so poorly constructed that not infrequently the whole boat, laboratory and equipment, has sunk. In the spring of 1899 it was important that the Commission should have more room for its work, and it seemed desirable to extend the biological observations to the west side of the Bay. As a temporary expedient an old scow was purchased, and upon this a small house was built, largely out of waste material given by the University, several students assisting in the construction. The scow was towed to Wickford on May 1st, where it has since remained. It is a miserable old craft, a disgrace to the State, and now beached to prevent its sinking; but the scientific work that it has enabled the Commission to carry on has far more than paid for its construction and the annoyance of its maintenance. Moreover, it has proved that a house-boat is the most practical design for a shore laboratory, and that it affords the most convenient means for carrying on the work of artificially increasing the marine products of the Bay.

Your Commission has inquired into the probable cost of constructing a suitable floating laboratory, and finds that a house 10 x 10, supported upon two pontoons each 50 ft. in length and giving a breadth of beam of 16 ft., can be built and equipped for about $1,000. Such a structure, enclosing an open well 46 ft. in length, and 8 ft. in width, will serve not alone for investigation, but will make an excellent hatchery in which millions of eggs now annually wasted may be artificially hatched, and it will also provide appropriate enclosures for partially rearing lobster fry.

The properties that have come into the possession of the Commission, and that are now in its custody, are not inconsiderable. There is a small open sailboat, 15 ft. in length, purchased in 1899, and two small skiffs, one at the Kickemuit, the other at Wickford. All these boats are in excellent repair. The small laboratory at the Kickemuit is provided with instruments, glassware, collecting sieves, nets, fish-cars, and implements for work along shore; and the larger scow at Wickford is equipped with mooring chains, two heavy mushroom anchors, a complete camping outfit, laboratory glassware, instruments, and the more ordinary pieces of collecting and retaining apparatus.

The receipts and disbursements of the Commission have been as follows:

State of Rhode Island in Account with Commissioners of Inland Fisheries.

1898.	DR.	
Dec. 31.	To balance due Commissioners........................	$37 50
1899.		
Aug. 27.	To paid for 20,000 yearling trout	669 14
Dec. 31.	To paid for investigating star-fish, flat-fish, clams, and lobsters, including house-boat........................	1,537 24
	To paid for expenses of Commissioners................	496 63
	To paid for boat	75 00
		$2,815 51

1899.	CR.	
May 30.	By cash of State Treasurer...........................	$396 26
	" " "	37 50
	" " "	7 10
	" " "	134 68
July 3.	" " "	50 44
	" " "	46 44
	" " "	200 00
24.	" " "	35 00
	" " "	30 00
27.	" " "	94 18
	" " "	120 30
	" " "	47 88
	" " "	47 35
Aug. 29.	" " "	49 71
Sept. 8.	" " "	60 00
Oct. 31.	" " "	88 44
	" " "	9 00
	" " "	8 05
	" " "	150 00
	" " "	60 00
	" " "	62 91
Dec. 27.	" " "	600 00
	" " "	6 10

1899.	Cr.	
Dec. 31.	By cash of State Treasurer	$32 60
	Balance due Commissioners	441 57
		$2,815 51

J. M. K. SOUTHWICK,
HENRY T. ROOT,
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HERMON C. BUMPUS.
Commissioners of Inland Fisheries.

1. The Stocking of our Ponds and Streams with Suitable Fresh-water Fish, Through the Distribution of Eggs and Fry.

Brook Trout.

During the past year the Commissioners have purchased 20,000 yearling trout and, with the assistance of anglers interested in the restocking of the streams, we have been enabled to distribute these young throughout the State. Although the streams have been unusually low during the open season, many excellent catches have been reported.

The success attending the work of the commission in restocking depleted streams has been very gratifying. Reports from all parts of the State show a large increase in numbers caught by fishermen. It was reported on good authority that hundreds of pounds of trout were taken from Tomaquog River in the town of Hopkinton, in a stream which a few years ago was nearly, if not quite, barren.

Large-mouthed Black Bass.

The efforts of the commission during the past three years to introduce this species into the waters of the State seem to have been successful. In all waters where they have been placed, specimens have been seen or caught that have shown rapid growth. Through the courtesy of the U. S. Commission, two thousand fry were received during the past season, and distributed as follows:

Richmond Pond	400
One Hundred Acre Pond	500
Pawcatuck River	100
Roger Williams Lake	1,000

Small-mouthed Black Bass.

The fishing for this species has been exceptionally good, particularly in Watchaug Lake, where the fish taken have averaged much larger than in several years past. Three hundred fry were received from the U. S. Fish Commission, and liberated in Pasquiset Pond, Washington County. It is the aim of the commission to introduce, as rapidly as possible, both species of black bass into all waters of the State not already stocked.

Land-locked Salmon.

The introduction of this valuable food and game fish is still largely experimental. The method adopted thus far has been to place the young fish in the waters of Mill Brook, a tributary to Watchaug Lake, in the town of Charlestown, where, with protection, they might grow until of sufficient size to enter the deeper waters of the Lake. Although no fish have thus far been caught in the lake proper, several mature fish have been seen in the Pawcatuck River, into which this lake empties through Poquiant Brook. Fifteen thousand fry were placed in Mill Brook in May, 1899. The United States Commission has kindly promised twenty thousand eggs for 1900, which will be hatched by the American Fish Culture Company, at Carolina, R. I., and will be reared by them until eight months old, when they will be distributed in Mill Brook and other suitable waters.

2. THE COLLECTION OF DEFINITE DATA RESPECTING THE TIMES OF ARRIVAL AND DEPARTURE OF VARIOUS FOOD-FISHES, AND THE STATISTICS OF EXPORTATION.

It has been almost impossible, because of the difficulty of moving from place to place, for the commission to secure reliable data relative to the times of arrival of the various food fish. But for upwards of twenty years, Mr. Vinal N. Edwards, of Woods Hole, has kept a careful record, and from this record Mr. George H. Sherwood has made the following statement. [The fish generally arrive off the shores of Rhode Island several days before their arrival at Woods Hole.]

On the beginning of April, the average temperature of the water is about thirty-seven degrees, and late in the month, when the water has reached a temperature of about forty-six degrees, the scup make their first appearance. At about the same time the menhaden arrive, and the mackerel on several occasions have been taken on May 1st, when the average temperature is only forty-seven.

The times of arrival of the blue-fish have been gradually postponed from year to year, until, in 1899, none were taken in Buzzard's Bay until June 23. In 1878 they arrived as early as the 8th of May, when the water has an average temperature of fifty degrees. From 1880 to 1890, the average time of their arrival was about one week later, when the water has a temperature of fifty-two degrees. From 1890 to 1899, the mean time of their arrival was June 10, when the temperature of the water reaches sixty degrees. Of course it is well-known that, whereas twenty years ago the blue-fish might have been taken by the hundreds it is now captured only in small numbers, or as scattering individuals.

The squeteague have not departed materially from the mean time of their arrival, that is, about May 11, when the water has a temperature of fifty-one degrees. The remarkable increase in the catch of squeteague is in marked contrast to the decrease in the catch of blue-fish.

The following tables are similar to those that have been published heretofore by the Commission. They show a gratifying increase in the number of fish shipped from Newport, although the data by no means represent the actual conditions. Many fish are taken to the New York market in smacks and by private steamer, and the lobsters shipped from Newport are not all taken from our own shores. The sword-fish, one hundred and sixty-two in number, were much more abundant than in previous years.

Shipment of Fish and Lobsters by Regular Lines of Freight Transportation from Newport, for the Years 1898 and 1899.

	1898.	1899.	1898.	1899.	1898.	1899.
	Bbls. Fish		Bbls. Lobsters.		Number. Swordfish.	
January	518	561	11	296	..	..
February	509	276	..	519	..	..
March	112	224	1	362	..	..
April	475	2,004	38	578	..	..
May	11,583	12,971	219	584	..	6
June	8,668	6,945	212	489	..	38
July	3,144	3,869	432	642	14	6
August	3,378	3,237	213	401	7	52
September	2,351	2,106	25	182	1	26
October	2,441	1,575	4	51	..	18
November	648	804	5	15	52	8
December	235	345	13	24	..	8
Total	34,065	34,917	1,163	4,143	74	162

Total of fish and lobsters, 1898 : 35,228 barrels.
Total of fish and lobsters, 1899 : 39,222.

The following is a tabulated statement of the relative quantities of fish shipped by freight from Newport, over the Old Colony ilnes for the past fourteen years :

Table of Shipments by Old Colony Lines.

	Fish. Bbls.	Lobsters. Bbls.	Total.
1886			17,434
1887	16,657	834	17,491
1888	15,033	1,161	16,194
1889	19,306	2,047	21,353
1890	8,933	2,650	11,583
1891	18,032	2,204	20,236
1892	26,832	2,123	28,955
1893	24,452	1,399	25,851
1894	17,769	2,392	21,161
1895	24,622	2,119	26,741
1896	20,425	1,728	22,153
1897	20,900	1,959	22,859
1898	34,065	1,163	35,228
1899	33,664	665	34,329

3. A CONTINUATION OF THE OBSERVATIONS ON THE BREEDING PERIOD OF NATIVE MARINE ANIMALS.

The Commission gave its reasons for undertaking this line of work in the report for 1898. It has continued its record during the past year, and will make a final report at some subsequent time.

4. THE LOCATION OF FISH-TRAPS WITHIN THE WATERS OF NARRAGANSETT, AND THE COLLECTION OF STATISTICAL DATA BEARING UPON THEIR OWNERSHIP.

With the publication of the report for 1898, the State first came into possession of definite data respecting the location and ownership of fish-traps. Assisted by the boats of the U. S. Fish Commission, your Commission has again visited all the fish-traps, located them upon its chart, and determined their ownership. We would repeat that the equipment and maintenance of these appliances represent the investment of considerable capital, and the employment of a large number of men. A large proportion of the fish captured are consumed beyond the limits of the State, and the list of cities to which shipments are directly made indicates very clearly the reputation which the State must enjoy as a fisheries centre. It is unnecessary to argue that large sums of money are brought into the State through the activities of those immediately interested in this industry. A list of the principal owners of fish-traps is here given, together with the localities at which the traps are set.

Almy, Frank K. (00)*	Sakonnet River.
Baker, Peter	Patience.
Brayton, R	Prudence.
Brayton, R. (00)	Prudence.
Brightman, Wm. J	Sakonnet Point.
Carpenter Bros	Saunderstown.
Carpenter, Geo	Beaver Head.
Church, Dan	Narragansett Pier.
Cook, C	Sakonnet Point.
Corey, Ed. (00)	Sakonnet River.
Corey, Ed. (00)	Sakonnet River.
Corey, Geo. and Martin (000)	Sakonnet River.
Corey, Geo. and Martin (00)	Sakonnet River.
Cottrell, S	Popasquash.
Cottrell, S	Popasquash.
Cottrell, S	Bristol.
Cottrell, S	Mt. Hope.
Cottrell, Wm	Tiverton.
Cottrell, Wm. (00)	Tiverton.
Culver, Geo	Coggeshall's Ledge.
Doane, S. P	Rumstick.
Easterbrooks, Comer (00)	Price's Neck.
Fish, Clinton	Tiverton.
Fish, Clinton (00)	Tiverton.
Gladding, A. B	Brenton's Point.

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*The signs (00) and (000) indicate double and triple traps.

Gladding, A. B	Coddington Cove.
Gray, Geo. E	Sakonnet River.
Gray, Geo. E. (0000)	Sakonnet River.
Gray, Geo. E	Sakonnet Point.
Gray, Geo. E	Sakonnet Point.
Griffin,———	Watson's Pier.
Grinnell, Philip	Sakonnet River.
Grinnell, Philip (00)	Sakonnet River.
Grinnell, Philip (00)	Sakonnet River.
Grinnell, Philip (00)	Sakonnet River.
Harvey, Charles	West Shore.
Helger Henry (00)	Sakonnet River.
Hicks, O. G	Brenton's Point.
James, Arnold	Coddington Cove.
Lake, Isaac	Conanicut.
Lake, Isaac	Quonset Point.
Lawton, Ed	Mackerel Cove.
Lawton, Wm	Mackerel Cove.
Lawton, Ed	Brenton's Point.
Lawton, Ed	Brenton's Cove.
Lewis Bros	Plum Beach.
Lewis Bros	Plum Beach.
Lewis Bros	Wild Goose Point.
Lewis Bros	Sauga Point.
Lewis Bros	Conanicut.
Lewis Bros	Conanicut.
Lewis Bros	Conanicut.
Lewis Bros	Conanicut.
Manchester, Daniel	Quonset Point.
Mitchel, Gordon	Conanicut.
Northrop Bros	Beaver Tail.
Peckham Bros	Sachuest Cove.
Rice, Herbert	Potowomut.
Rice, Herbert	Potowomut.
Rose, Wm	Conrad's Cove.

Rose, Wm	Coggeshall's Ledge.
Rose, Geo. O	West Shore.
Rose, Ed	Sakonnet River.
Seabury Ben. (00)	Sakonnet River.
Shepard, J	Bristol.
Shepard, J	Popasquash.
Simons, Wm	Sakonnet River.
Spink, J. W	Beaver Tail.
Spink, J. W	Conanicut.
Spink, J. W	Conanicut.
Spink, J. W	Prudence.
Sirmons, John M.	Tiverton.
Sirmons, John M	Tivevton.
Sisson,———	Allen's Harbor.
Sisson,———	Chippanogsett.
Taber,———	Tiverton.
Tew, Eugene and Geo	Cherry Neck.
Tew, Walter	Sachuest Point.
Tourjee, P	Beaver Tail.
Tourjee, P	Beaver Head.
Tourjee, Steven	Saunderstown.
Wait, Ben	Sakonnet Point.
Wilcox, Frank	Sakonnet Point.
Wilcox Bros. (00)	Sakonnet River.
Wilcox Bros. (000)	Sakonnet River.
Wilson, Al	Potowomut Rocks.
Wilson, Al	Prudence.

Sea-Traps.

Brightman, W. J	Off Seal Rock.
Brightman, W. J	Off Coggeshall's Ledge.
Church, J. B., and Brownell, J. M	Off Seal Rock.
Church, J. B., and Brownell, J. M	Off Coggeshall's Ledge.
Cottrell, Geo. F	Off Cormorant Rock.
Gladding, A. B	Off Coggeshall's Ledge.

Macomber, Frank	Off Cormorant Rock.
Rose, Wm. R.	Off Seal Rock.
Thompson, Noah	Off Seal Rock.

5. Observations to Show the Influence, if any, that Trap-Fishing May Have Upon Line-Fishing.

The influence that the trap-fishing in the lower portion of the bay may have upon the abundance of food-fish in the upper portion of the bay has been an oft-disputed question. The heat of argument at any time has been in inverse ratio to the number of fish visiting our shores. The general question of the inexhaustibility of sea products has received special attention during the past year. W. C. McIntosh, director of the Scottish Marine Laboratory at St. Andrews, and for several years member of the Fishery Board, has endeavored to show, in his book "The Resources of the Sea," that there is little danger of over-fishing, that restrictive legislation is unnecessary, and that Nature is amply able to maintain an abundant supply, no matter what demands may be made upon her. Views so entirely at variance with the convictions of those who have made fishing a profession, so radically different from the opinions of those who occupy positions that have enabled them to study the abundance of various commercial fishes from year to year, and views that deliberately set at nought the legislative provisions of the various maritime countries, have naturally been seriously questioned, and the discussions have certainly brought many facts to the surface that otherwise would have remained unknown.

So far as our own interests are concerned, there seems to be little question that certain of our native fishes have been sadly reduced in numbers through neglect and excessive fishing, but the abundance of many forms which annually come in from the open ocean, and visit our shores for the purpose of breeding, appears to remain unaffected. For all that there have been no fewer than 100 traps, set at various places along the shores of the lower portion of the bay, the line-men have had all the scup and squeteague fishing that they could desire. Indeed, scup were never more abundant in Narragansett Bay than during the past season, and the squeteague were never more plentiful. Rod and line fishermen were literally satiated. The young of both these fish have been seen in enormous numbers in the more shallow inlets, and there is every indication that the coming year will be quite as productive as the past.

During the last two days of October and the first six days of November there was a run of mackerel along the shores of Cape Cod, as unexpected as the numbers were unprecedented. Although many traps had been removed, and the mackerel fleet had abandoned work for the season, fully six thousand barrels of mackerel of large size and excellent quality were taken from the shores of Cape Cod Bay, not to mention those that were taken from the southern shores of New England. The sudden appearance of such an enormous number of large fish is evidence that the mackerel has not suffered seriously from the wholesale methods of capture to which it has been subjected, for according to all accounts the fish that were taken were only the scattering individuals along the edge of a veritable migratory wave passing from the north toward the south.

It is certainly worthy of note that while Rhode Island is profiting by her one hundred fish-traps, giving employment to many of her residents, and receving a generous income from her exports, Buzzards Bay, although offering no greater inducement to the hook and line fishermen, is yielding little or nothing because of the closure of the area to the trap-fishermen by legislative enactment.

6. The Continued Examination of the Physical and Biological Conditions of the Waters of the Bay, Begun in 1898.

Through the courtesy of the U. S. Fish Commission, we have been enabled to collect additional data of a physical and biological nature, which will be retained by the Commission until ready for publication.

7. EXPERIMENTS TO TEST THE FEASIBILITY OF CLAM-CULTURE.

Mindful of the alarming decrease in the number of clams annually taken from the shores of the State, your Commissioners have begun a series of investigations to test the feasibility of clam-culture. It was the purpose to prepare certain tracts of the shore line, and to plant small clams under varying conditions, to the end that we might know their rate of growth and secure data that might enable us to proceed more intelligently and more effectually the coming season; or, if convinced of the impracticability of clam-culture, to divert our energies in other directions.

Inasmuch as the laws of the State do not provide for the preemption of any portion of the shore for this or similar lines of work, and since the experiments might come to an untimely end at the hand of those who claim a right to all portions of the shore line, your Commission thought it best to conduct the experiments on tracts of land controlled by the United States government, where trespassing could be prevented, and where a general supervision of the grounds could be maintained during the winter months without expense to the State.

Seventy-one plats, each containing one hundred square feet, were selected at four localities, the places chosen being selected because of their extreme physical differences. One had a hard gravelly bottom, covered at high tide by water containing debris and refuse material from various sources. The second locality was partially covered by large rocks more or less imbedded in a hard mud almost like clay. The third point selected for observation was a locality where clams had once abounded, and where a few still remained. The soil was a loose muddy sand of dark color, relatively free from stones and refuse material. None of the clams found on this bed were less than two and a half inches in length, and were of the thick-shelled variety, evidently of slow growth. This bed was the largest upon which we operated, and it was exposed only at exceptionally low tides. The fourth locality was selected because it appeared to be a place where the native clam grew with greater rapidity. There was a free circulation of clear water, and the soil was of varying consistency, ranging from light sand to a deep slimy mud.

In all the above cases, alternate squares, each containing one hundred square feet, were "cultivated," the soil spaded over to the depth of a foot, and all large stones removed. The soil was then raked, and by means of a movable frame divided into small squares measuring one foot along each side.

Seed clams were taken from different localities, some from the warm water of shallow estuaries, others from the cooler water of the coast line, and still others, "paper shells," from protected sandy coves. All the clams, several thousand in number, were carefully measured, sorted into sizes, and registered. In transplanting, care was taken to place the clams not always under the most favorable conditions, and a record was kept of the exact spot in which each clam was placed. In each of the four localities the clams were distributed some according to their source, others according to their size, some were crowded together, and others were given a superabundance of room. Some were driven deep into the mud; others were placed near the surface. Some were placed where they would be always covered by the water, and others were placed near the high-tide mark. At the end of the season, as a further precaution, signs were placed over the beds, prohibiting people from molesting them, and there is, up to the present time, no evidence that the beds have been disturbed. It is now our purpose to leave these beds until the clams have been in their new environment for at least a year, when they will be remeasured, their rate of growth recorded, and we shall then possess some idea as to the feasibility of planting and protecting the young until they are of marketable size.

8. A PRELIMINARY SURVEY OF THE SHORES OF THE BAY, FOR THE PURPOSE OF DETERMINING THOSE PORTIONS WHICH IN THE PAST WERE PRODUCTIVE CLAM BEDS.

Your Commission has spent considerable time in visiting various portions of the bay, and finding from the older residents those localities which have been known to be productive clam beds. These data are on file with the Commission, and when we have added to them the areas now naturally seeded by the remarkable set of 1899, it is our purpose to issue a chart which will show the total area which might be inhabited by the clam.

9. AN INVESTIGATION OF THE LIFE-HABITS OF THE CLAM, ITS BREEDING PERIOD, ITS FOOD, ITS RATE OF GROWTH, ITS NATURAL ENEMIES, AND EXPERIMENTS TO TEST THE FEASIBILITY OF ARTIFICIAL PROPAGATION.

This work was intrusted to Dr. A. D. Mead, who has prepared the following report:

OBSERVATIONS ON THE SOFT-SHELL CLAM.

BY A. D. MEAD, BROWN UNIVERSITY.

The following "comparative statement of the yield of clams in the New England States during a series of years" shows of what importance the clam industry has been in our State. It shows also a very considerable decrease in the yield of clams since 1880, and at the same time a marked increase in the price per bushel.

The statistics were arranged by Dr. Hugh M. Smith, of the U. S. Fish Commission, and with the exception of one item, were published in the report of the Commissioner for 1894. Through the kindness of Dr. Smith the data for Rhode Island for 1898 are added.

Maine.

	Bushels.	Value.
1880	318,383	$101,808
1887	608,780	228,490
1888	600,675	227,665
1889	595,105	200,761
1892	416,806	157,431

New Hampshire.

1880	17,960	$8,980
1887	280	140
1888	300	150
1889	300	150
1892	1,050	975

Massachusetts.

	Bushels.	Value.
1880	158,626	$76,195
1887	230,659	121,202
1888	243,777	127,838
1889	240,831	137,711
1892	191,923	133,529

Rhode Island.

1880	53,960	$48,564
1887	25,825	25,030
1888	30,825	30,030
1889	33,375	32,475
1892	33,950	45,222
1898	15,015	20,569

Connecticut.

1880	75,000	$38,000
1887	26,735	25,370
1888	26,575	24,270
1889	26,360	24,900
1892	23,780	25,320

Total.

1880	623,929	$273,547
1887	892,279	400,252
1888	902,152	409,953
1889	895,961	395,997
1892	667,509	362,477

The Extent of Shore in Narragansett Bay Available for Rearing Clams.

From its geographical peculiarities, our State is particularly well adapted for clam culture; the Bay has a long shore line for so small a body of water, on account of the many peninsulas, estuaries, and islands, and nearly all the shore is protected from the heavy seas. In order to ascertain how much of the shore in this State is suitable for the growth of clams, a preliminary survey of the bay was made.

Through the courtesy of the United States Fish Commission, the steam launch Blue Wing was detailed to aid in collecting this information, together with data concerning the location of fish-traps, and the density and temperature of the water in various parts of the Bay. A considerable extent of the shore was examined directly, but for most of the information we are indebted to numerous fishermen and other residents, who from long experience have particular knowledge of certain localities.

There are in the aggregate more than fifty miles of shore which is considered good clam ground, and this is not limited to any portion of the Bay, but is found in all parts, wherever in fact there is soil enough for the clams to bury themselves. It is not by any means necessary that the ground should be soft, for hard clay and exceedingly stony ground often yield a good crop of clams. In many localities, also, no clams occur above the mean low-water mark, while they are comparatively abundant lower down and can be dug in the ordinary manner when the tide is uncommonly low. Nowhere, however, are the clams abundant to-day, and it is the common testimony from all parts of the Bay that, although they were exceedingly abundant from ten to twenty-five years ago, they are now comparatively scarce. The shores are, at present, almost depleted, and the difficult process of "churning" them in several feet of water is often resorted to by those who make a business of supplying clams to the market.

The set of clams was exceptionally large last summer (1899) in various parts of the Bay, for example about Green's Island (Conimicut), at Wickford, in the Kickemuit river, and on Oakland Beach. It will be interesting to observe how long the clams will remain abundant in these localities.

Since the above was written, on February 5 and 6, (1900), there were a great many bushels of extremly large clams in the markets.

They were taken from the flats in various parts of the bay at Wickford, the Kickemuit river, and other localities, when the tide was phenomenally low. One of the largest specimens, taken from Wickford, measured 5¾ inches in length and weighed 15 ounces; and a bushel taken at random from the market contained only 119 clams.

Egg-Laying, and Habits of the Very Young Clams.

The eggs of the clam, like those of the oyster, are exceedingly minute. Like the latter, also, they are extruded into the water where they are fertilized, and where they develop into free-swimming larvæ. The exact limits of the egg-laying period of the clam have not been determined, but it probably extends through the months of May and June, as Dr. Kellogg conjectured in the last Report.

On the eighth and on the twelfth of May the clams examined at the Kickemuit river were full of sexual products, which appeared under the microscope to be nearly ripe. On May 22 I succeeded in fertilizing some of the eggs artificially by dissecting them out into a dish of sea-water and adding the sperm taken from the male clam in the same way. The early stages of development were regular and apparently normal, but, unfortunately, I could not remain at the house-boat to care for the eggs, and they died. The experiment proved, at least, that the clams were ready to breed toward the last of May, and that it is possible to fertilize the eggs artificially.

On May 29 a silk net was obtained which was fine-meshed enough to hold many of the free-swimming young of the clam, and from this date until the second week of July these minute clams were taken at Wickford almost every day by dragging the net along the surface of the water.

The specimens caught in this way are hardly visible to the unaided eye. By the aid of the microscope they are seen to have two shells hinged together, and in this respect they resemble the adult clam. In order to procure them for examination the skimming-net is shaken out in a dish of water. The clams may then be separated from the myriads of other small organisms by gently tapping the dish, when they will stop swimming, close their shells, and fall to the bottom. They are then easily picked up with a pipette, and transferred in a drop of water to a watch crystal under the microscope. When first caught they vary considerably in size, some being four times the diameter of others, as shown in the figure (Fig. 1). As one watches these specimens under the microscope he will frequently see one of them open its shell, thrust out and expand a circular swimming-organ and go whirling about in the water for a while; then as suddenly, this organ, the velum, is drawn in, the shells close over it, and the clam falls to the bottom and remains quiet. Figure 4 is a free-hand sketch of one of these swimming clams (caught on May 29) with the swimming-organ expanded. Around the margin of the latter are the rapidly moving cilia, which create a current of water in the direction indicated by the arrows. This specimen had struck a snag, and was held by it while the sketch was made; smaller organisms and particles of dirt were swiftly swept backwards, meanwhile, by the energetic strokes of the cilia. In the midst of the organ is a long, slowly moving flagellum or lash, which may, perhaps, serve as a feeler.

Inasmuch as there are no published figures of the clam at this stage, it was not possible upon the mere examination of these creatures to say definitely that they were the young of the soft-shelled clam. It was presumed that they were, however, not only from their appearance but from the fact that the adult clams a week or two before were ready to lay, and, further, from the fact that by the last of June the young set of clams is well started. (See Kellogg's Report, 1898.) The absolute proof that they were clams was forthcoming, however, for a number of specimens were isolated and kept alive in dishes for several weeks. During the first week or two they grew considerably, lost their swimming-organ, and took on unmistakable characters of the soft-shelled clam. Figure 2 is from a camera drawing of one of these living clams two weeks after it was caught, *i. e.*, on June 14. It is drawn to the same scale of magnification as those in figure 1. The shape of the shell has been greatly changed, and the clam is more than twice the length, and many times the bulk, of even the largest specimen when first caught. The siphon (snout), gills, liver, stomach, and heart, and the relatively large foot have been developed, the internal organs showing plainly through the transparent shell. Figure 3 represents the same individual, drawn with the camera, to the same scale, ten days later, on June 24. The body is now still further elongated, the gill-plates are considerably more numerous, the foot is, perhaps, somewhat larger in proportion, and a peculiar sense organ, the so-called ear, is plainly visible within the substance of the foot. The lines of growth, which can be easily made out upon the shells themselves, show the changes in shape which have taken place during the process of growth. Although the rate of growth in this specimen is seen to have been quite rapid—from the size of one of those in Fig. 1 to that in Fig. 3 in less than three weeks—it was doubtless much less rapid than it would have been under natural conditions; for this specimen was kept in a dish, the water being changed only a few times, so that the supply of food, which consists of microscopic organisms, was very meagre as compared with that in the tide-water.

Among the clams caught in the skim-net there were usually many in which the foot and siphons were already developed. Such specimens, when watched under the microscope, would crawl about by means of the foot instead of swimming; yet they must have been able to swim, since they were taken near the surface of the water. I am not certain whether the swimming-organ was still capable of being used, or whether they swim with the foot. The latter method I would have thought almost impossible had I not seen it in use by razor clams which were many times larger. On the evening of July 20 a large number of razor clams, some of the latter measuring seven millimetres (more than a quarter of an inch), were taken in the tow-net. The shells were well-formed and hard, but the animal swam rapidly about by means of a curious kicking stroke of the very long foot. They were never taken in the tow except on this occasion, a rainy evening when a strong wind was blowing.

Whatever method of swimming the young clams may finally use, it is certain that they swim freely in the water until the foot and siphon are developed and they are thus equipped for crawling about over the sea-weed, stones, sand, and other objects they happen to strike upon.

A specimen whose swimming-days were past is represented in Fig. 5. The double nature of the siphon is shown at this stage, the incurrent and excurrent portions being almost separate from each other. The dotted lines represent the foot as it appears when the shell is closed, and the foot thrust out is represented by the solid lines. It is impossible to obtain more than a hasty camera sketch of the outstretched foot because its movement is so quick. The foot reaches out sometimes considerably further than the picture indicates, takes hold of the bottom of the dish, and with a quick jerk the shell is pulled up to it, the whole operation not occupying more than a second or two. By this rather clumsy method of travelling the clam is able to make considerable progress.

A few days after the clams are caught at the surface they are found to have attached themselves to the bottom of the dish or to any object which happens to be near them. Kellogg found last year these very small specimens attached to sea-weeds and other objects and carefully studied their habits from this period of life, when they are less than one-fiftieth of an inch in length, until they are finally settled in the ground. He showed that they attach themselves to objects by spinning byssus threads as the mussels do, but that they can at pleasure release themselves from the attachments, crawl about and attach themselves again. The ability to attach itself remains until the clam is upwards of one-half an inch in length, and by this time most of the clams which survive have buried themselves in the ground. Fig. 24 is a life-size photograph of a small clump of clams anchored by byssus threads to a mussel-shell and to stones. As Kellegg pointed out, this capacity is of greatest advantage to the clams; for those which happen to set upon sea-weed, stakes, stones, etc., are able, with some degree of safety, to wander about until they find a suitable place in which to burrow, and those which are not satisfied with the ground where they first burrow can come out and go to a new place, as they were actually seen to do. Of the greatest utility, however, is the habit of anchoring themselves in the burrow so that they cannot be so easily washed out.

While the rock-weed and other algæ are of great service to the clams in furnishing them with a convenient temporary lodgment where they will not be smothered by the silt when they are very small, it is true also the clams set in great quantities and grow in some sandy beaches where there is no sea-weed.

Some General Features of the Clam Set.

By the first week in July, 1899, a great many clams had already found their way into the sand. At this time they were so small that they escaped general notice, ranging from a size at which they were hardly visible to 9 millimetres in length. (See Fig. 6). By the third week in July a great majority had burrowed, and then there were probably more of this year's clams in the sand than at any other time during the year, for during the next few months they were destroyed in enormous quantities. Although the free-swimming young were, in their season, abundant at all times and at places in the water of the harbor (Wickford), the set of clams which was found buried in the sand was very unevenly distributed. The sandy shore in some places was literally filled with them from below low-water mark to about the half-tide mark. Here it would be impossible to pick up a handful of sand without taking up with it several clams. Within a few rods of these specially fertile areas however, in the same sort of soil, only a comparatively few clams were to be found—not one-thousandth as many as in the former places.

It was very apparent in these cases that the abundance or scarcity of the set was not due to the quality of the soil nor to the quantity of old clams in the vicinity, nor yet to the absence of enemies, but was due probably to the position of the shore with reference to the tide currents. Some of the areas where the set was exceedingly thick were, moreover, far from being the best for adult clams, and the reason is not far to seek. In one case a certain point of shore was set in the middle of July as thickly as the clams could burrow, but by the ninth of August hardly a young clam could be found. They were apparently washed out or were covered with shifting sand. In another locality, about 40 rods from the last, the set was discovered on July 5 and was also very thick. These clams continued to be abundant throughout the summer and autumn, and, though meanwhile they were somewhat thinned out, were yet very numerous on December 4. The thinning out began in July, and from this time until September there was always a wind-row two or three feet wide of small clam-shells along this portion of the shore. Very often among these shells one would find live clams and preying upon them a whole army of star-fishes, crabs of various species, and mummichogs. Undoubtedly the crabs, especially the blue crabs "paddlers," and some other animals dig up or uncover the young clams and scatter them about where they fall prey to many enemies; but I think one important factor in their wholesale destruction lies in the fact that they set much thicker than they can grow and a great many are crowded out, or, at least, if they are once brought to the surface of the ground, cannot burrow again. When the clams are not more than one-fourth of an inch long—early in July—they were near together, but when by the last of July they had become several times longer and many times the bulk, they actually touched each other; for at this period they all buried themselves to about the same depth. As one walked over the ground, or tapped it, the whole surface for a yard or two would move perceptibly as the clams contracted.

A more definite notion of the abundance of the clams in the locality mentioned above will be gained from the following: On August 9, after they had become somewhat thinned, a square yard on the shore was staked out and the clams dug from it as carefully as possible. These were carefully picked over and all stones and shells sorted out. There were then ten pints of clams. Two pints were counted, the first yielding 1,200 clams, the second 1,300. The average of the two pints was therefore 1,250, and the estimate for the clams (ten pints) taken from one square yard is 12,500. In addition to these a considerable number, perhaps a thousand, were lost, being scattered by the tide.

The Rate of Growth.

The rate of growth of the clam, like that of the star-fish, is, under favorable circumstances, more rapid than is usually supposed. It was shown in the last Report that the rate of growth in the star-fish varied greatly according to the amount of food, and that of two healthy star-fishes of the same age one might be more than one hundred times the bulk of the other. The same variation, resulting from differences in food supply, is seen in the clams, though perhaps the difference is not so great.

The growth of the clams, which set thick at Wickford, on Cornelius Island, was followed during the summer, and formed the basis for comparing the growth in other localities. The following figures, photographed life-size, will show the rate of growth of the clams in this locality. Figure 6 represents specimens taken July 7; the larger of these are probably about five or six weeks old, judging from the data with regard to setting already mentioned. Any possible doubt that they are the set of this summer is removed by the fact that a large number of specimens set on the house-boat, which was put into the water on the first of May, were about the same size.

The succeeding figures, from 7 to 14 inclusive, are all life-size photographs of clams taken from the same locality as those in Fig. 6, at various times during the summer. The specimens photographed were selected as representing the average size on each date, together with some of the larger and smaller sizes, placed in the bottom and top row, respectively.

The Rate of Growth Under Specia Conditions.—On the sixth of July about a pint of clams, taken from the point already referred to, were placed in a box of sand in the house-boat, and about one-half pint more were added on July 9. The clams were not covered with the sand, but were simply scattered over the surface, many of them sticking together in clumps. In about five minutes they had all burrowed out of sight. The sand box was sunk about 18 inches below the surface of the water, and, not being affected by the rise and fall of the tide, was kept submerged at this depth for a month. During the following month, it was occasionally exposed at low tide when the house-boat was ashore.

The growth of these specimens was compared from time to time with that of the clams in the original locality on the shore, and with the somewhat surprising result that the clams at the house-boat grew much faster than those on the shore, whence the former were originally taken. It is clear, therefore, that it is not necessary for the rapid growth of the young clams that they be in a locality which is exposed at low tide—on the contrary they grow faster when they are submerged all the time. This difference in the growth of the clams on the shore and in the house-boat is illustrated by the photographs of samples taken from two localities at various times. Compare Fig. 9 with Fig. 14; also Figs. 10 and 15; Fig. 11 and Fig. 17; Fig. 12 and Fig. 18.

It might be asked whether the more rapid growth at the house-boat was not due to the more favorable position of the latter in the tide currents. This may be true in some measure, but yet the point of shore in question was washed by a strong current also. The house-boat, moreover, was moored within a few rods of the point, so that the character of the food is about the same. Some other observations confirmed the conclusion that clams grow faster when they are continuously submerged. On September 7, on another part of the shore, the young clams were examined at various levels, from below mean low-water mark to half tide, and the larger growth of the former was noticeable. This is illustrated by samples which were taken at very low tide, and at about half-tide (Figs. 21 and 22).

The following experiment, made to ascertain the rate of growth of individual clams transplanted to another locality on the shore, shows, also, that the growth is greater near the low-water mark. On the 22d of July a number of young clams of average size, taken from the point on Cornelius Island, were carefully measured, and planted in the land tiles. The tiles were set perpendicularly into the ground, and filled with sand taken from *above* tide mark, in order that no clams might be accidentally put into them, and were arranged in a row, from extreme low-water mark to high-water mark, at intervals of about two feet. Each clam was carefully measured and placed in a tile by itself (in some cases two specimens were put into the same tile). On September 18 some of these were taken out and measured again, the rest being left undisturbed. The measurements are of the long diameter of the shell, and are given in millimeters. The accompanying diagram shows the relative position of the tiles which contained the specimens measured on September 18. No. 1 is at extreme low tide, and No. 8 some what below half-tide mark.

Number.	July 22.	September 18.	Growth in 2 Months.
(8)	13mm	28mm	15mm
(7)	12 "	36 "	24 "
(6)	14 "	40 "	26 "
(5)			
(4)	11 "	44 "	33 "
(3)	13 "	46 "	33 "
(2)	15 "	48 "	33 "
(1)	13 "	gone.	

Reference to this table shows at once that the clams grow more slowly as we go up the shore from low-water mark. Compare for example Nos. 3 and 8, which at the time of planting were of the same size, but two months afterwards differ 15 millimeters, or more than one-half an inch.

It is not certain, of course, that the difference of rate of growth at different levels is always as marked as in this case, and more experiments must be tried to ascertain the relative growth accurately. This experiment, so far as it goes, substantiates the conclusion already stated that clams grow faster when they are under water the greater part of the time. The reason for this is not very far to seek. The food of the clams consists of microscopic organisms contained in the water, which is taken in through one siphon and expelled through the other. The clams can feed, therefore, only when covered by water, and those which are located at some distance above the low-water mark are shut off from the food supply during a considerable portion of each day.*

This record of growth of the clams in the tiles is interesting also because it demonstrates that clams may grow during their first summer nearly to marketable size. The specimen in tile No. 2 was not among the very largest of the set on the point at the time it was transplanted, and not larger than some of those which had set in the floating house-boat; so that there is no question about it being of this year's production. On July 22 it measured 15 millimeters—the size of the specimen in Fig. 20. On September 18, in less than two months, it had more than trebled its length and had burrowed about six inches into the sand. The specimen was preserved on September 18 and is photographed natural size in Fig. 20 by the side of a clam of fifteen millimeters in length. The growth of the two adjacent specimens in the tiles Nos. 3 and

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*Since the rapidity of growth of the clams depends directly upon the supply of microscopic organisms in the water, it is to be expected that a considerably greater growth will be found in some portions of the Bay than in others. I have not had an opportunity to investigate this problem carefully, but through the kindness of Mr. A. W. Bourne some samples of this year's clams were obtained on December 5 which were much larger than those taken at the same time at Wickford. The water in the former locality is extremely rich in microscopic organsims, shown both in the skimmings taken with a tow-net and by the remarkable growth of animals other than clams which depend upon these organisms for food.

4 indicates that the record for the specimen photographed is not exceptional or accidental.

Another experiment made to ascertain the rate of growth of individual clams was tried at the house-boat. On July 19 several specimens were carefully measured and placed in small flower-pots which were filled with sand. These were kept continuously under water, and the clams measured again on September 10. The measurements on the two dates, as given below, show that the clams had grown during seven and a half weeks to two or three times their original length.

Record of Growth of Clams in Pots at House-Boat.

Number.	July 19.	September 10.
(1)	11-11 (2 specimens).	26-23
(2)	9.2	22
(3)	7.5	—
(4)	8.1	27
(5)	12.5	28
(6)	10.9	30
(7)	11.1	25
(8)	8.9	30
(9)	10.5	22 (shell only).
(10)	11.5	20 (shell only).
(11)	11.1	27
(12)	9.0	26

The following will give an idea of the relative increase in bulk of the clams at the house-boat as compared with those on the shore. On August 9 the clams on the point of shore to which we have several times referred were measured by the pint and counted. The average number to the pint was about 1,200. The clams which were taken from the same locality on July 7 and 9, and which had been kept in a box of sand at the house-boat since that date, now measured about 400 to the pint. The clams at the house-boat, therefore, appeared to have so far outstripped those on the shore that in one month they became about three times the bulk of the latter. There is one possible fact, however, which may make this result less trustworthy than the data derived from the growth of marked individuals or from that of the largest specimens in each locality, viz.: the clams which were placed in the house-boat were gathered with a sieve, which, though its meshes were small (ordinary flour-sieve), may have allowed many of the smaller clams to go through; so that the average size of those planted was perhaps less than the average size of those remaining on the shore.

The actual increase in bulk of a certain quantity of clams during ten weeks in the summer is given in the following measurement of the clams reared in the house-boat. The box of sand in which a pint and a half of small clams was planted as evenly as possible, on July 6–9, was divided in the middle by a partition. The clams soon became so crowded that many were probably pushed out; at any rate there was a considerable number of empty shells over the surface of the sand. Notwithstanding this loss, four and a half quarts were taken from one-half of the box on September 18, the other half being left undisturbed. From about three-fourths of a pint, therefore, we had a yield of over four quarts of clams in about ten weeks. We ought also to mention that one pint was taken from the box on August 5, and smaller quantities on several other occasions.

Size and Age at Sexual Maturity.

It is usually maintained that the clam reaches sexual maturity during the third year of its life,* but I am inclined to believe that this does not do justice to the animal in question, and that the clam, like the star-fish, not only grows faster, but arrives at sexual maturity much sooner than is usually supposed. My reasons are as follows :—

1. I found at the beginning of the breeding-season a ripe male

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*See Bulletin 51, R. I. College of Agriculture and Mechanic Arts, December, 1898.

clam of 30 millimeters in length, and a ripe female of 50 millimeters. As we have already stated, many clams, undoubtedly of this year's growth, were more than 30 millimeters long, and some nearly 50 millimeters, before the end of September.

2. In the autumn the sexual glands of this season's clams were considerably developed, although the breeding-season does not occur until spring.

Therefore, while I cannot make it as a positive statement, not having yet followed the development of the sexual glands throughout the year, I would venture the conjecture that many of the clams of last summer's set (1899) will breed next spring (1900).

Summary of Preceding Chapters, and Bearing of These Results on the Problem of Clam Culture in Narragansett Bay.

(1) From the point of view of clam culture, and the practicability and feasibility of re-instating an almost defunct industry, the observations recorded in the preceding pages open up a very encouraging prospect.

(2) The preliminary survey indicates that there are more than fifty miles of Rhode Island shore in the Bay alone which are more or less available for the rearing of clams.

(3) The range and the adaptability of the clam is great. It will thrive in various kinds of soil; in sand, mud, clay, and among stones; from near high-water to considerably below low water; from brackish ponds to the densely salt water of the outside shore and Seaconnet river.

(4) It is the general testimony that the clams have been decreasing in quantity gradually during the last twenty years, and it is an undisputed fact that they are now comparatively scarce. The disappearance has been nearly uniform in all parts of the Rhode Island shore of the Bay; in localities protected from the wash of the steamers and not contaminated by the waste of towns, as well as in localities less fortunately situated. It is still, in certain localities, comparatively abundant below the low-tide mark,

where it cannot be taken by the ordinary method of digging, but only by the more elaborate and unusual method of churning. In Cole's river, where, under Massachusetts laws the clams are better protected, they are much more abundant than in the neighboring Rhode Island estuary, Kickemuit river, though both are similarly situated and the latter has been proved by its past history to be a locality as favorable as the other. These facts and others indicate clearly that the decrease in the clams of the State is due mainly to the unlimited and promiscuous digging and not to changed natural conditions.

(5) That frequent digging up of the ground is necessary, or that it is even a positive benefit to the clams, by rendering the ground soft, is probably a fallacy. The fact that often the finest specimens are found in hard, stony ground, or in hard clay flats, which are only occasionally exposed to the clam-digger at an unusually low tide, and the observations made during the summer upon the growth of unmolested specimens, indicate that they grow well, at any rate, if left undisturbed. The habits of the animal, in obtaining food, point to the same conclusion. The food is obtained from the water which is taken in through the siphon, and not from the soil in which the clam lies. So long as it is well located, therefore, and in communication with the water it is distinctly not to its advantage to be disturbed, particularly at the risk of being buried deep under the mud or left on the surface, a prey to crabs, mummichogs, star-fish, and other enemies. Clams less than one-half an inch long will burrow very rapidly when they are exposed on the surface of the mud (if covered by water), but those upwards of three-fourths of an inch will often lie for a long time without even trying to burrow, and then are not very efficient in getting into the mud. This method of "cultivation," although undoubtedly excellent for apple trees, is not, however, equally good for clams.

(6) The breeding-season of the clam is at its height in June. The exact limits of the period have not been ascertained. The eggs are extruded in great numbers into the sea-water where they

are fertilized and in a short time develop into very minute free-swimming forms with little resemblance to the adults. In this condition they live an active life and are carried hither and thither by the tides for several days at least before they settle down to the bottom or attach themselves to some object like a stone or piece of sea-weed. The obvious result of this method of reproduction is that the young clams do not remain where the eggs are laid but are very widely distributed by the tides. This fact readily explains the sudden appearance of a large set of clams in a locality where the adults are scarce. It is not at all unlikely, moreover, that the clams below tide-mark, and out of reach of their human enemy, produce a large proportion of the clams which set on the shore. (See foot-note, p. 32.)

(7) In the manner of setting, and in the peculiar characteristics of the young clams after they have set, there are two facts which will prove of the greatest service in clam culture. 1. The clam set is not evenly distributed even in regions of the Bay where the water is full of the free-swimming young, but in some localities the set is extremely thick while in neighboring localities, a few rods distant, only a small number may be found. 2. The young clams, from one-fourth to one-half an inch long, have a remarkable capacity for burrowing, a capacity which is greatly diminished as the animal grows larger. At the proper season, therefore, and in the localities where the set is thick, the clams can easily be collected in immense numbers by means of a sieve; and fortunately the time when they can be collected with the least difficulty happens to be the very best time for transplanting. By far the best time for collecting and transplanting is from the first week in July to the first or second week in August. It is hundreds of times easier to collect them at this season by means of a sieve than at other times of the year with a clam-hoe. There is perhaps even a greater advantage in transplanting at this time, from the fact that the clams can now be sowed broadcast like grain and will soon burrow into the sand; whereas, larger specimens from one inch upwards must necessarily be planted and carefully covered

or a great loss will result. An additional fact in favor of transplanting at this time is that in some localities there are very great quantities of young clams set early in July which, if not taken up and transplanted, are destroyed by shifting sand or from some other cause. In other localities the clams are set too thick to grow to the best advantage, and they would actually be benefited by being thinned out.

(8) It seems almost certain that the explanation of the abundant set in a limited area, and the meagre set in the neighboring localities, is to be sought in the position of the shore with reference to the tides. When this explanation has been worked out in detail it may be possible artificially to construct and place apparatus to collect the set in equally large quantities.

(9) The experiments of transplanting have demonstrated that under favorable conditions the rate of growth is more rapid than is usually supposed, some of this year's set having reached a length of nearly two inches by the middle of September. The experiments demonstrate also, the fact that there are great differences in the rate of growth according to the food supply which is obtained from the water, and that the most rapid growth may be expected of clams which are under water most of the time.

(10) The size and age at which the clams reach sexual maturity has not been definitely ascertained, but there are facts which indicate strongly that they breed during the first year of their life. It has elsewhere been stated that they do not breed until the third year. The question is important, of course, in view of any attempt at clam culture on a large scale or at restocking the shores.

EXPLANATION OF FIGURES.

1. Sketches, drawn with camera lucida, of young, free-swimming clams, showing shape and variation in size.

2. Camera drawing made on June 14 of a clam caught in the skim-net at the surface of the water on May 29, and kept isola-

ted in a dish of water. Seen from the left side: f, foot retracted; l, liver; h, heart; g, gills; s, siphon or "snout." Arrows indicate incurrent and excurrent openings.

3. The same individual as Fig. 2, drawn to the same scale of magnification, ten days later, viz.: on June 24; e, sense organ (ear?). Other letters the same as Fig. 2.

4. Freehand sketch of clam larva seen through the microscope with swimming-organ (velum) expanded. Around the edge of the velum is the fringe of minute lashes (cilia) whose movements propel the animal. The arrow shows the direction of the current of water created by the rapid stroke of the cilia. The direction of the current is easily ascertained by observing the movement of the small particles contained in the water.

5. Sketch of a clam just set, as seen under the microscope. The large foot and the siphon are shown distended. The dotted line indicates the position of the foot when retracted within the shell. The incurrent and excurrent tubes of the siphon are, at this stage, nearly separate.

6. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on July 7, 1899. The largest specimens are, probably, about six weeks old. Photograph life-size.

7. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on July 14, 1899. The largest specimens are, probably, about seven weeks old. Photograph life-size.

8. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on July 21, 1899. The largest specimens are, probably, about eight weeks old. Photograph life-size.

9. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wick-

ford, R. I., on August 4, 1899. The largest specimens are, probably, about ten weeks old. Photograph life-size.

10. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on August 29, 1899. The largest specimens are, probably, about thirteen weeks old. Photograph life-size.

11. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on September 7, 1899. The largest specimens are, probably, about fourteen weeks old. Photograph life-size.

12. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on September 30, 1899. The largest specimens are, probably, about four months old. Photograph life-size.

13. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on December 4, 1899. The largest specimens are, probably, about six months old. Photograph life-size.

14. Specimens selected to represent the average size of the clams in a marked area on the shore of Cornelius Island, Wickford, R. I., on December 4, 1899. The largest specimens are, probably, about six months old. Photograph life-size.

15. Specimens selected to represent the average size of clams taken on July 7, 1899, from a marked area on Cornelius Island, Wickford, R. I., and reared in a sand-box at the house-boat until August 8. These specimens are, probably, about ten and a half weeks old. Compare with those remaining on the shore until August 4. Photograph life-size.

16. Specimens selected to represent the average size of clams taken on July 7, 1899, from a marked area on Cornelius Island, Wickford, R. I., and reared in a sand-box at the house-boat until August 29. These specimens are, probably, about thirteen weeks

old. Compare with those remaining on the shore until August 29. Photograph life-size.

17. Specimens selected to represent the average size of clams taken on July 7, 1899, from a marked area on Cornelius Island, Wickford, R. I., and reared in a sand-box at the house-boat until September 8. These specimens are, probably, about fourteen weeks old. Compare with those remaining on the shore until September 7. Photograph life-size.

18. Specimens selected to represent the average size of clams taken on July 7, 1899, from a marked area on Cornelius Island, Wickford, R. I., and reared in a sand-box at the house-boat until Septemper 19. These specimens are, probably, about sixteen weeks old. Compare with those remaining on the shore until September 30. Photograph life-size.

19. The large specimen was taken on September 18 from a land-tile set in the mud on the shore (Wickford), at low-water mark. It was placed in the land-tile on July 22, when it was the size of the smaller specimen. The difference in size represents two months' growth. Photograph life-size.

20. These specimens represent the average size of the larger of the clams at low-water mark in a certain locality on the shore at Wickford on September 7. (Compare with those from the same locality at *half-tide* mark.) Photograph life-size.

21. These specimens represent the average size of the larger clams at half-tide mark in a certain locality at Wickford on September 7. (Compare with those from the same locality at *low-water* mark.)

22. These specimens were found among the barnacles clinging to the outside of the house-boat on September 7. They have never been covered with sand or soil of any kind, and are stubby and thick-shelled. Photograph life-size.

23. These specimens were taken on September 7, from the side of the sand-box in the house-boat, and show how the clams of considerable size may remain anchored to various objects, or

to each other, so as to form clumps, like mussels. Photograph life-size.

24. These specimens represent the average (smaller) size of clams taken from the shore in the Kickemuit River on December 4. They are about six months old. Photograph life-size.

25. These specimens represent the average (larger) size of clams taken from the shore in the Kickemuit River on December 4. They are about six months old. Photograph life-size. Compare with those taken at Wickford, on shore, at the same date.

10. Continued Work on the Off-shore Fisheries.

In the last report attention was called to the existence of valuable fishing-grounds lying but a short distance from our coast, and inhabited by apparently large numbers of valuable food-fish. At that time the trawls had been set in thirteen different localities between the meridian of 69° and 71° of W. longitude, between parallels of 40° and 40° 20′ N. latitude, and in water ranging from 70 to 80 fathoms in depth. Although this work was carried on by the U. S. government, the fact that the tile-fish bank lies immediately to the south of Rhode Island renders its exploration of especial interest to the fishermen of the State. During the past summer the Grampus made three excursious to the Gulf Stream for the purpose of determining the northern and western limits of the area inhabited by the fish. Three of your commissioners accompanied the vessel on one of these expeditions. As a result of the work of 1899 the western limit of the "bank" was carried some miles to the westward of the meridian of 72°, south to the parallel of 39° 47′, and the fish were followed into shallow water of only 55 fathoms depth. At our very doors is this wealth of fish which rival the halibut in quality.

11. Efforts at Lobster-Culture.

The predictions that have been so often made in regard to the disastrous results that must follow the unrestricted capture of immature lobsters and the destruction of egg-bearing females are being realized. Means more efficient for the annihilation of the lobster could scarcely be devised than those now employed. It is legal to capture and kill at all times of the year, and the animals are destroyed illegally without respect to size or sex. The spawn of the few egg-bearing lobsters which approach our shores from the deeper water is combed from the appendages, destroyed, and the sterile mother carried to the market.

With an important industry thus threatened with early extinction, the Commission has adopted the only means within its power to ward off the calamity. It has continued the experiments begun in 1898, which were described in its twenty-ninth report.

Early in May a member of your commission, and two assistants, established themselves at Woods Hole, receiving an unlimited number of lobster-fry from the government hatchery. It has been suggested often that if the fry could be placed in a small bay of salt water and protected from their enemies, they would doubtless flourish and come to maturity. Through the kindness of Camillus G. Kidder, Esq., a small enclosure was placed at our disposal, the bottom was carefully cleaned, a dike was built to make the enclosure more secure, and after repeated seinings we considered the enclosure freed of animals that might prey upon the fry. After testing the temperature and specific gravity of the water, several thousand lobster-fry were liberated, but on the following day not a single one could be found. The young seemed to perceive the slightest movement of the water, and following the current, probably passed out through the minute crevices in the embankment. The further possibility of their escaping in this manner was then prevented by placing lengths of scrim across the openings; but the fry would attach themselves to the cloth, at the ebb of the tide, and, there entangled, would become exposed to the sun and perish. Repeated experiments convinced us that until we could find a larger natural enclosure, further work in this direction would be profitless.

The importance of suitable and sufficient food was emphasized in the last report, and if the young are not provided with such they perish soon after they have escaped from the egg. We have succeeded in finding an excellent food, a food that is practically the same as that giving nutriment to the embryo while within the egg.

It is a well-known fact that the food-yolk of the lobster's egg is finally stored in the liver of the growing embryo, and at the time of hatching the supply of this material is nearly exhausted. The liver of the adult lobster, (the greenish-colored gland, so delicious to the taste, and often called the "fat,") is made up of a number of short fibres, which may be readily cut up into morsels practically microscopic. These float about in the water and are easily devoured by the fry, a single liver being sufficient to feed many thousands. As soon as the lobsters leave the hatching-jars, they are placed in Chester jars, the water of which is kept in active movement, and a small quantity of the subdivided liver is added. In a short time the lobsters appear to have changed in color, but a more careful examination will show that the change is only apparent, and not real. It is due to the presence within the stomach and intestine of the yellow-fat-bearing food, which can be seen easily through the transparent body-walls, and which often marks out the shape and extent of the entire alimentary tract. So characteristically does it mark the animals that have fed that they may be removed from their less active, injured, sluggish, or indifferent companions, and placed where they will have more room and a more natural environment than the whirl of the hatchery.

It is our opinion that, thus artificially fed, the young are not so prone to feed upon one another as those starved into cannibalism, and we feel convinced that the food is a determining factor in the problem of brooding.

We have found that the most suitable enclosure is a car, not with rigid walls of wood, wire, or scrim, but rather a large bag of scrim made after the fashion of a fish-pocket, and hanging down into the water from a square floating frame. The bag waves back and forth in the current, giving a gentle motion to the water, and this motion appears to be very essential to the well-being of the larvæ, for without it they settle to the bottom and slowly die.

While the larvæ are in the scrim enclosures, they may be fed with the lobster liver, but this is likely to pollute the water, and, gathering on the upper portion of the scrim, rapidly decays. It is here that the scrim-bags again prove their fitness for this work, for it is a very simple matter to "purse" them up, and gently lead the young into a clean bag, without handling them, and without injuring them in any way. The frequent change from soiled to clean scrim enclosures appears to be essential to the well-being of the young, and is to be recommended for reasons of economy; since the scrim rots if allowed to remain a long time in the sea-water.

Later in the season we found that the older fry appeared to flourish better on living than on prepared food. The living food is doubtless much more natural for them than the finely subdivided liver, and it is certainly much more cleanly. It would of course be very satisfactory if we could find the young of some fish which we could raise in the hatchery, and then liberate in the scrim-bags, the young lobsters catching such as they desired and leaving the others alive until they too were needed for food. In this connection, the young of the goose-fish gave us some encouragement, but they are colored with black blotches, and this color seems not to attract the young lobsters. This indifference of the young lobsters was a disappointment, for the spawn of the goose-fish can be gotten by the tub-ful. It readily hatches in the laboratory, and the young flourish in the scrim enclosures.

But it is not a difficult matter, although a somewhat irksome task, to skim a sufficient quantity of copepods and other surface material to provide an abundance of natural food for the young lobsters. At a certain time of the day, or at certain times of the tide, the plankton (the small floating organisms of the ocean) come to the surface, and a boy with a skimming-net and a boat can soon collect enough to feed thousands of fry. The net is simply drawn through the water and occasionally hauled in, turned inside out, and rinsed in a bucket of sea-water. The rinsings contain myriads of minute organisms, which, poured into the scrim enclosures, are eagerly devoured by the young lobsters.

By the methods above described, and after many failures, accidents, and reverses, we succeeded in raising several hundred lobsters up to the fourth moult, at which time, as previously mentioned, they take on many of the habits of the adult, and have, for their general resemblance to the adult, been called lobsterlings.

Although artificial lobster-culture has been attempted in other countries, we think the efforts of last summer were far more successful than any heretofore reported, and we are encouraged that at no far-distant date we shall be able to report on a successful and practical method of lobster-culture.

The interest attached to the Woods Hole experiments induced your Commissioners to report the results of their work at the meeting of the American Fisheries Association in June, and some idea of the endurance of the lobsterlings when properly nourished may be gained from the fact that during the extremely hot weather a number of these were carried from Woods Hole to Niagara Falls, where they remained without change of water during the meeting, and were then taken back to Woods Hole and again liberated, only a very few individuals perishing on the journey.

12. Distribution of Lobster-Fry.

Your Commission has received upwards of a million lobster fry from the Government hatchery at Woods Hole, and has distributed these in the waters of Narragansett Bay.

13. The Preparation of a List of the Fishes Known to Inhabit the Bay.

Your Commission is often in receipt of strange fishes taken in traps, washed ashore, or captured by hook and line. These have been preserved, and now form the nucleus of a collection. A list of the fishes known to inhabit the waters of Narragansett Bay has never been published, and the following list has been drawn up for the convenience of those who may be interested in the fish fauna of the State. It is based upon data now in the possession of the Commission, and it is our intention to publish a more extensive paper at some subsequent time. Any facts relative to the subject will be gladly received.

PETROMYZONIDÆ. THE LAMPREYS.

Petromyzon marinus (Linnæus). *Great Sea Lamprey; Lamprey Eel.*

GALEIDÆ. THE REQUIEM SHARKS.

Mustelus canis (Mitchell). *Smooth Dogfish; Dogfish; Switchtail.*
Carcharhinus obscurus (Le Sueur). *Dusky Shark; Shovel-nose.*

SPHYRNIDÆ. THE HAMMER-HEADED SHARKS.

Sphyrna zygæna (Linnæus). *Hammer-headed Shark; Hammerhead.*

ALOPIDÆ. THE THRESHER SHARKS.

Alopias vulpes (Gmelin). *Thresher; Thrasher; Swingle-tail.*

CARCHARIDÆ. THE SAND SHARKS.

Carcharias littoralis (Mitchill). *Sand Shark.*

LAMNIDÆ. THE MACKEREL SHARKS.

Isurus dekayi (Gill). *Mackerel Shark.*

SQUALIDÆ. THE DOG-FISHES,

Squalus acanthias (Linnæus). *Dog-fish; Horned Dog-fish.*

RAJIDÆ. THE SKATES.

Raja erinacea (Mitchill). *Summer Skate; Bonnet Skate.*
Raja ocellata (Mitchill). *Big Skate; Winter Skate.*
Raja lævis (Mitchill). *Barndoor Skate.*

NARCOBATIDÆ. THE ELECTRIC RAYS.

Tetranarce occidentalis (Storer). *Torpedo; Crampfish.*

DASYATIDÆ, THE STINGRAYS.

Dasyatis centrura (Mitchill). *Sting Ray.*

MYLIOBATIDÆ. THE EAGLE RAYS.

Rhinoptera bonasus (Mitchill). *Cow-nosed Ray; Sting Ray.*

ACIPENSERIDÆ. THE STURGEONS.

Acipenser sturio (Linnæus). *Sturgeon.*

SILURIDÆ. THE CAT-FISHES.

Galeichthys felis (Linnæus). *Sea Cat-fish.*

ANGUILLIDÆ. THE TRUE EELS.

Anguilla chrysypa (Rafinesque). *Eel.*

LEPTOCEPHALIDÆ. THE CONGER EELS.

Leptocephalus conger (Linnæus). *Conger Eel.*

ELOPIDÆ. THE TARPONS.

Tarpon atlanticus (Cuvier & Valenciennes). *Tarpon.*
Elops saurus (Linnæus). *Ten-pounder ; Big-eyed Herring.*

CLUPEIDÆ. THE HERRINGS.

Clupea harengus (Linnæus). *Sea Herring; Herring: Sperling.*
Pomolobus mediocris (Mitchill). *Hickory Shad.*
Pomolobus pseudoharengus (Wilson). *River Herring; Alewife.*
Alosa sapidissima (Wilson). *Shad.*
Opisthonema oglinum (Le Sueur). *Thread Herring.*
Brevoortia tyrannus (Latrobe). *Menhaden; Pogy.*

ENGRAULIDIDÆ. THE ANCHOVIES.

Stolephorus brownii (Gmelin). *Striped Anchovy; Anchovy.*
Stolephorus mitchilli (Cuvier & Valenciennes). *Anchovy.*

SALMONIDÆ. THE SALMON FAMILY.

Salmo salar (Linnæus). *Salmon.*
Salvelinus fontinalis (Mitchill). *Brook Trout; Speckled Trout.*

ARGENTINIDÆ. THE SMELTS.

Osmerus mordax (Mitchill). *Smelt.*

SYNODONTIDÆ. THE LIZARD-FISHES.

Synodus fœtens (Linnæus). *Lizard-Fish.*

PŒCILIIDÆ. THE KILLIFISHES.

Fundulus majalis (Walbaum). *Mayfish; Killifish.*
Fundulus heteroclitus (Linnæus). *Common Killifish; Mummichog.*
Fundulus diaphanus (Le Sueur). *Spring Minnow; Killifish.*

ESOCIDÆ. THE NEEDLE-FISHES AND GAR-FOSHES.

Tylosurus marinus (Walbaum). *Garfish; Billfish; Bill Eel.*

HEMIRAMPHIDÆ. THE HALFBEAKS.

Hyporhamphus roberti (Cuvier & Valenciennes). *Halfbeak; Skipper.*

SCOMBERESOCIDÆ. THE SAURIES.

Scomberesox saurus (Walbaum). *Saury; Skipper; Billfish.*

GASTEROSTEIDÆ. THE STICKLEBACKS.

Gasterosteus bispinosus (Walbaum). *Two-spined Stickleback.*
Apeltes quadracus (Mitchill). *Four-spined Stickleback.*

FISTULARIIDÆ. THE CORNET-FISHES.

Fistularia tabacaria (Linnæus). *Trumpet-fish.*

SYNGNATHIDÆ. THE PIPE-FISHES.

Siphostoma fuscum (Storer). *Pipe-fish.*

HIPPOCAMPIDÆ. THE SEA-HORSES.

Hippocampus hudsonius (De Kay). *Sea-horse.*

ATHERINIDÆ. THE SILVERSIDES.

Menidia gracilis (Günther). *Silverside.*
Menidia notata (Mitchill). *Silverside. Brit.*

MUGILIDÆ. THE MULLETS.

Mugil cephalus (Linnæus). *Striped Mullet; Jumping Mullet.*
Mugil curema (Cuvier & Valenciennes). *White Mullet.*

SPHYRÆNIDÆ. THE BARRACUDAS.

Sphyræna guachancho (Cuvier & Valenciennes). *Barracuda.*

AMMODYTIDÆ. THE SAND LAUNCES.

Ammodytes americanus (DeKay). *Sand Launce; Lant; Sand Eel.*

SCOMBRIDÆ. THE MACKERELS.

Scomber scombrus (Linnæus). *Common Mackerel.*
Auxis thazard (Lacépède). *Frigate Mackerel; Bonito; Tunny.*
Thunnus thynnus (Linnæus). *Horse Mackerel; Tunny.*
Sarda Sarda (Bloch). *Bonito.*
Scomberomorus maculatus (Mitchill). *Spanish Mackerel.*
Scomberomorus regalis (Bloch). *Kingfish; Cero.*

TRICHIURIDÆ. THE CUTLAS-FISHES.

Trichiurus lepturus (Linnæus). *Cutlas-Fish; Scabbard-Fish.*

ISTIOPHORIDÆ. THE SAIL-FISHES.

Tetrapterus imperator (Bloch and Schneider). *Spearfish.*

XIPHIIDÆ. THE SWORD-FISHES.

Xiphias gladius (Linnæus). *Sword-fish.*

CARANGIDÆ. THE POMPANOS, CREVALLÉS, AMBER-FISHES, ETC.

Naucrates ductor (Linnæus). *Pilot-Fish.*
Seriola zonata (Mitchill). *Shark-pilot; Rudder-fish; Pilot-fish.*
Seriola lalandi (Cuvier and Valenciennes). *Amber-fish.*
Decapterus punctatus (Agassiz). *Round Robin; Scad; Cigar-fish.*
Decapterus macarellus (Cuvier and Valenciennes). *Mackerel Scad.*
Trachurops crumenopthalmus (Bloch). *Goggler; Big-eyed Scad.*
Alectis ciliaris (Bloch). *Gobbler-fish; Threadfish.*
Vomer setipinnis (Mitchill). *Horse-fish; Dollar-fish.*
Selene vomer (Linnæus). *Lookdown; Dollar-fish.*
Trachinotus falcatus (Linnæus). *Round Pompano.*
Trachinotus carolinus (Linnæus). *Common Pompano.*

POMATOMIDÆ. THE BLUE-FISHES.

Pomatomus saltatrix (Linnæus). *Blue-Fish.*

NOMEIDÆ. THE NOMEIDS.

Nomeus gronovii (Gmelin). *Portuguese Man-of-War-Fish.*

CENTROLOPHIDÆ. THE RUDDER-FISHES.

Palinurichthys perciformis (Mitchill.) *Rudder-Fish; Polefish.*

STROMATEIDÆ. THE BUTTER-FISHES.

Rhombus paru (Linnæus). *Harvest-Fish; Long-finned Butter-Fish.*
Rhombus triacanthus (Peck). *Butter-Fish.*

SERRANIDÆ. THE SEA BASSES.

Roccus lineatus (Bloch). *Striped Bass; Rockfish.*
Morone americana (Gmelin). *White Perch.*
Epinephelus niveatus (Cuvier & Valenciennes). *Snowy Grouper.*
Centropristes striatus (Linnæus). *Sea Bass; Black Bass.*

LOBOTIDÆ. THE TRIPLE-TAILS.

Lobotes surinamensis (Bloch). *Flasher; Triple-Tail.*

SPARIDÆ. THE PORGIES.

Stenotomus chrysops (Linnæus). *Scup; Porgy; Scuppaug.*
Lagodon rhomboides (Linnæus). *Sailor's Choice; Pinfish.*
Archosargus probatocephalus (Walbaum). *Sheepshead.*

SCIÆNIDÆ. THE DRUMS.

Cynoscion regalis (Bloch & Schneider). *Weakfish; Squeteague.*
Leiostomus xanthurus (Lacépède). *Spot; Goody.*
Menticirrhus saxatilis (Bloch & Schneider). *Kingfish; Sea-Mink.*
Pogonias cromis (Linnæus). *Drum.*

LABRIDÆ. THE WRASSE-FISHES.

Tautogolabrus adspersus (Walbaum). *Cunner; Chogset.*
Tautoga onitis (Linnæus). *Tautog; Blackfish.*

BALISTIDÆ. THE TRIGGER-FISHES.

Balistes powelli (Cope). *Powell's Filefish.*
Balistes carolinensis (Gmelin). *Trigger-Fish; Leather-Jacket.*

MONACANTHIDÆ. THE FILE-FISHES.

Monacanthus hispidus (Linnæus). *Foolfish; Filefish.*

OSTRACIIDÆ. THE TRUNK-FISHES.

Lactophrys trigonus (Linnæus). *Trunkfish; Shellfish.*

TETRAODONTIDÆ. THE PUFFERS.

Lagocephalus lævigatus (Linnæus). *Smooth Puffer; Puffer.*
Spheroides maculatus (Bloch & Schneider). *Swellfish; Puffer.*

DIODONTIDÆ. THE PORCUPINE-FISHES.

Chilcomyterus schœpfi (Walbaum). *Swell-Toad; Puffer.*

MOLIDÆ. THE HEAD-FISHES.

Mola mola (Linnæus). *Sunfish.*

COTTIDÆ. THE SCULPINS.

Acanthocottus æneus (Mitchill). *Little Sculpin; Grubby.*
Acanthocottus grœnlandicus (Cuvier and Valenciennes). *Sculpin.*
Hemitripterus americanus (Gmelin). *Sea Raven; Red Sculpin.*

CYCLOPTERIDÆ. THE LUMP-SUCKERS.

Cyclopterus lumpus (Linnæus). *Lumpfish.*

BATRACHOIDIDÆ. THE TOAD-FISHES.

Opsanus tau (Linnæus). *Toadfish; Toad-Grunter.*

XIPHIDIIDÆ.

Pholis gunnellus (Linnæus). *Butter-fish; Rock Eel.*

ANARHICHADIDÆ. THE WOLF-FISHES.

Anarhichas lupus (Linnæus). *Wolf-fish; Catfish.*

ZOARCIDÆ.

Zoarces anguillaris (Peck). *Eel-pout; Sea Eel.*
Lycodes reticulatus (Reinhardt). *Eel-pout.*

TRIGLIDÆ. THE GURNARDS.

Prionotus carolinus (Linnæus). *Common Gurnard; Sea-robin.*
Prionotus strigatus (Cuiver and Valenciennes). *Sea-robin; Red Sculpin.*

CEPHALACANTHIDÆ. THE FLYING GURNARDS.

Cephalacanthus volitans (Linnæus). *Flying-robin; Flying Gurnard.*

ECHENEIDIDÆ. THE REMORUS.

Echeneis naucrates (Linnæus). *Shark Sucker; Remora.*
Rhombochirus osteochir (Cuvier). *Spearfish; Remora.*

MERLUCCIIDÆ. THE HAKES.

Merluccius bilinearis (Mitchill). *Silver Hake; Whiting; Frostfish.*

GADIDÆ. THE CODS.

Pollachius virens (Linnæus). *Pollock.*
Microgadus tomcod (Walbaum). *Tomcod; Frostfish.*
Gadus callarias (Linnæus). *Cod.*

Melanogrammus æglifinus (Linnæus). *Haddock.*
Phycis tenuis (Mitchill). *Squirrel Hake; White Hake; Hake.*
Phycis chuss (Walbaum). *Hake.*
Brosmius brosme (Müller). *Cusk; Ling.*

PLEURONECTIDÆ. The Flounders.

Paralichthys dentatus (Linnæus). *Summer Flounder; Flounder.*
Paralichthys oblongus (Mitchill). *Four-spotted Flounder; Flounder.*
Bothus maculatus (Mitchill). *Sand-dab; Window-Pane.*
Limanda ferruginea (Storer). *Rusty Flatfish.*
Pseudopleuronectes americanus (Walbaum). *Flatfish.*

SOLEIDÆ. The Soles.

Achirus fasciatus (Lacépède.) *Sole; Hog-Choker; Black Flatfish.*

LOPHIIDÆ. The Fishing-Frogs.

Lophius piscatorius (Linnæus). *Goosefish; Angler; Fishing-Frog.*

FRESH-WATER FISHES.

Catostomus commersonii (Lacépède). *Brook Sucker.*
Abramis crysoleucas (Mitchill). *Golden Shiner; Roach; Dace.*
Notropis cornutus (Mitchill). *Shiner; Red-fin.*
Lucius americanus (Gmelin). *Banded Pickerel.*
Perca flavescens (Mitchill). *Yellow Perch.*
Ameiurus nebulosus (LeSueur). *Horned Pout; Bullhead.*
Boleosoma nigrum olmstedi (Storer). *Darter.*
Eupomotis gibbosus (Linnæus). *Sunfish.*
Micropterus dolomieu (Lacépède). *Small-mouth Black Bass.*
Erimyzon sucetta (Lac). *Chub Sucker.*
Rhinichthys atronasus (Mitchill). *Black-nosed Dace.*
Lepomis auritus (Linnæus). *Long-eared Sunfish.*

14. A List of the Diatoms Found in the Water Over the Clam, Mussel, and Oyster Beds.

The food of the various shell-fish is composed very largely of diatoms, and localities abounding in natural sets of clams and oysters are generally rich in diatomaceous material. It is obvious therefore that before one can predict the adaptability of any locality to clam or oyster culture, some knowledge of the amount of diatomaceous food present is quite essential. The Commission is under obligations to Messrs. Henry Lothrop and Norman N. Mason for the following carefuly prepared list of diatoms from skimmings made at Wickford during July, 1899.

RAPHIDIEÆ.

Family 1. Cymbelleæ.

Amphora commutata.
“ excisa.
“ formosa.
“ incurva.
“ laevissima.
“ lanceolata.
“ lineata.
Amphora maxima.
“ minutissima.
“ obtusa.
“ ovalis.
“ recta.
“ veneta.
Cymbella lanceolata.

Family 2. Naviculeæ.

Mastogloia apiculata.
“ exigua.
Stauroneis acuta.
“ apiculata.
“ oblonga.
“ Phœnicenteron.
“ producta.
“ pulchella.
“ salina.
Navicula abrupta.
“ ambigua.
“ Americana.
“ anceps.
“ apis.
“ Bombus.
“ borealis.
“ cardinalis.
“ columnaris.
“ cryptocephala.
Navicula didyma.
“ diffluens.
“ elegans.
“ elliptica.
“ forcipata.
“ gibba.
“ gracialis.
“ granulata.
“ humerosa.
“ impressa.
“ lanceolata; var. curta.
“ latissima.
“ Liburnica.
“ longa.
“ lyra.
“ macra.
“ maculata.
“ marina.
“ Menisculus; var. peregrina.

Navicula mesolepta.
“ ovata.
“ peregrina.
“ praetexta.
“ producta.
“ pusilla.
“ radiosa.
“ retusa.
“ Smithii.
“ splendida.
“ viridis.
“ viridis; var. commutata.
“ sp.? very coarsely marked.
Pinularia fortis of Gregory.
Pleurosigma angulatum; var. aestuarii.
“ Balticum.
“ decorum.
“ elongatum.
“ Fasciola.
Pleurosigma rectum.
Schizonema Adriaticum.
“ Americanum.
“ amplius.
“ Smithii.
Plagiotropis gibberula.
Amphiprora alata.
“ conspicua.
“ constricta.
“ elegans.
“ lepidoptera.
“ minor.
“ ornata.
“ paludosa.
“ pulchra.
“ quadrifasciata.
“ sulcata.
“ vitrea.
Rhoicosphenia curvata.
“ setigera.
“ styliformis.

FAMILY 3. GOMPHONEMEÆ.

Gomphonema acuminatum; var. coronata.
Gomphonema capitatum.

FAMILY 4. ACHNANTHEÆ.

Achnanthes longipes.
“ parvula.
Achnanthes subsessilis.

FAMILY 5. COCCONIDEÆ.

Cocconeis amphiceros.
“ coronata.
“ crucifera.
“ interrupta.
“ lineata.
“ molesta.
“ nitida.
Cocconeis pseudomarginata.
“ scutellum.
“ scutellum; var. minutissima.
“ scutellum; var. stauroneiformis.

PSEUDO-RAPHIDIEÆ.

Family 6. Fragilarieæ.

Epithemia Argus.
“ gibberula.
“ granulata.
“ musculus.
“ turgida.
“ zebra.
Eunotia arcus.
“ monodon.
“ pectinalis.
Plagiogramma Gregorianum.
Dimeregramma minus.
“ nanum; var. minus.
Raphoneis amphiceros.
“ cocconeis.
“ capensis.
Asterionella formosa.
Synedra acus.
“ affinis; var. acumenata.
Synedra crystallina.
“ Danica.
“ delicatissima.
“ Gallionii.
“ lanceolata.
“ longissima.
“ pulchella.
“ robusta.
“ ulna.
“ undulata.
Licmophora Anglica.
“ Dalmatica.
“ flabellata.
“ tincta.
Fragilaria virescens.
Denticula elegans.
Diatoma vulgare.

Family 7. Tabellarieæ.

Tabellaria fenestrata.
“ flocculosa.
Grammatophora angulosa.
“ marina.
“ serpentina.
“ subtilissima.
Striatella arcuata.
“ interrupta.
“ unipunctata.
Rhabdonema Adriaticum.
Odontidium Harrisonii.
“ tabellaria.

Family 8. Surirelleæ.

Campyloneis Grevillii.
Cymatopleura campylodiscus.
Surirella cruciata.
“ delicatissima.
“ gemma.
“ minuta.
“ ovalis.
“ ovata.
Campylodiscus Echeneis.
“ ? Resembles Clypeus; A. S. Atlas, Pl. 54, Fig. 7.
Bacillaria socialis.
Nitzschia amphionyx.
“ apiculata.
“ bilobata.

Nitzschia calida.
“ coarctata.
“ communis.
“ constricta.
“ fasciculata.
“ frustulum.
“ Hungarica.
“ longissima.
“ marginulata.
“ marina.
Nitzschia navicularis.
“ panduriformis.
“ paradoxa.
“ plana.
“ puncta.
“ scutellum.
“ sigma.
“ “ var. diminuta.
“ vermicularis.
“ vitrea.

CRYPTO-RAPHIDIEÆ.

FAMILY 9. CHAETOCEREÆ.

Corethron criophillum.
Rhizosolenia Americana.
“ gracealis.
“ setigera.
“ styliformis.
“ sp.?
Syndendrium diadema.
Bacteriastrum furcatum.
“ varians, var. princeps.
Chaetoceros bacillaria.
“ barbatum.
“ boreale.
“ dispar.
“ didymus.
“ monicae; probably a melosira.
“ protuberans.
“ Wighamii.

FAMILY 10. MELOSIREÆ.

Pyxilla boreale.
“ Kittoniana.
Stephanopyxis turris.
Skeletonema costatum.
Melosira numuloides.
“ scalaris.
Melosira sculpta.
“ sulcata.
“ sp.?
Podosira hormoides.
“ maculata.
Goniothecium sp.?

FAMILY 11. BIDDULPHIEÆ.

Eucampia zodiacus.
Biddulphia aurita.
“ pulchella.
“ turgida.
Triceratium alternans.
“ Brightwellii.
Triceratium favus.
“ intricatum.
“ parallelum; var.
“ punctatum.
“ undulatum.

Family 12. Eupodisceæ.

Auliscus caelatus.

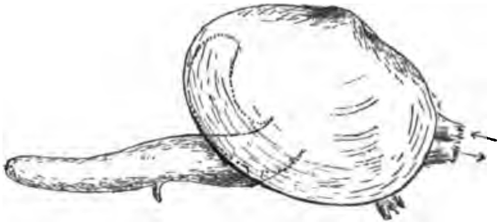
Family 13. Heliopelteæ.

Actinoptychus Grundleri.
Actinoptychus undulatus.

Family 15. Coscinodisceæ.

Craspedodiscus var.
Hyalodiscus subtilis.
Cyclotella compta.
“ stelligera.
“ stricta.
“ sp.?
Actinocyclus crassus.
“ Ralfsii.
Coscinodiscus concavus.
Coscinodiscus concinnus.
“ decipiens.
“ excentricus.
“ heteroporus.
“ patina.
“ radiatus.
“ subtilis.
“ sp.?

PLATE I.



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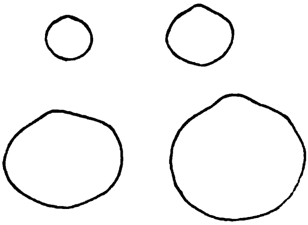

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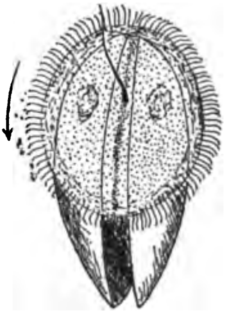

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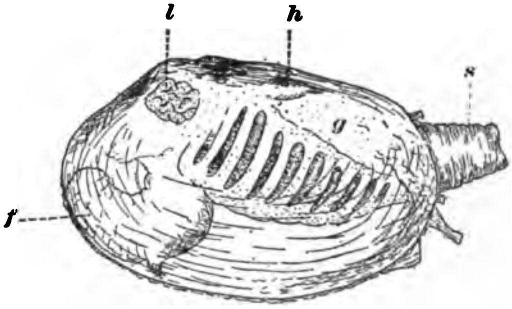

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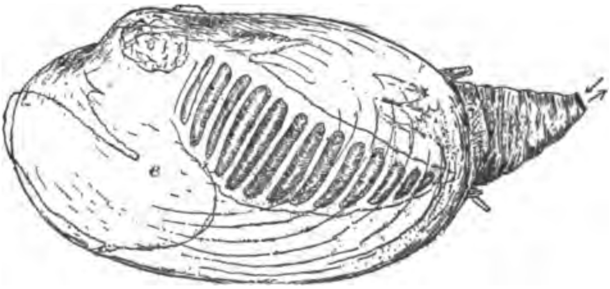

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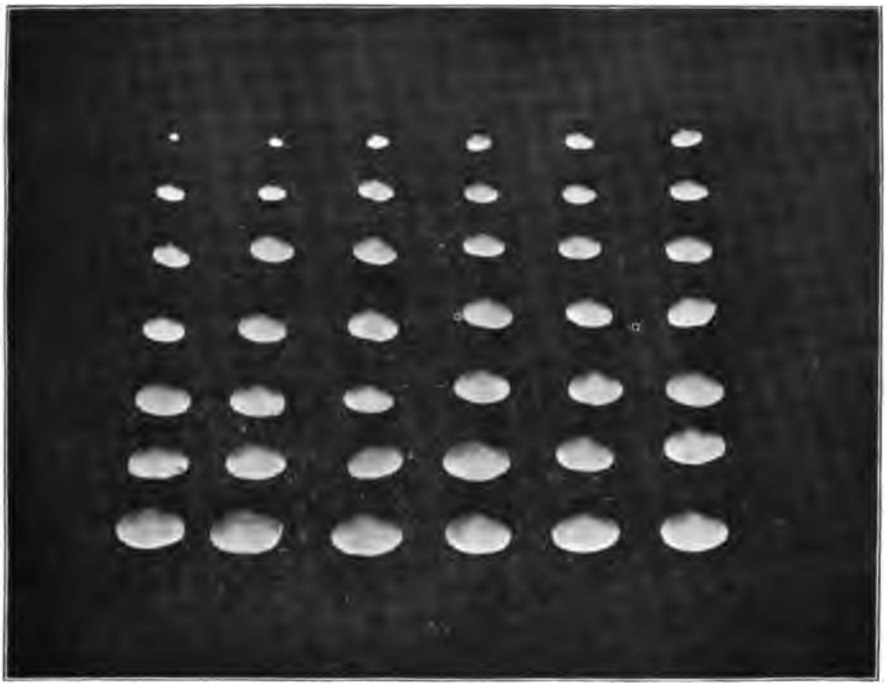

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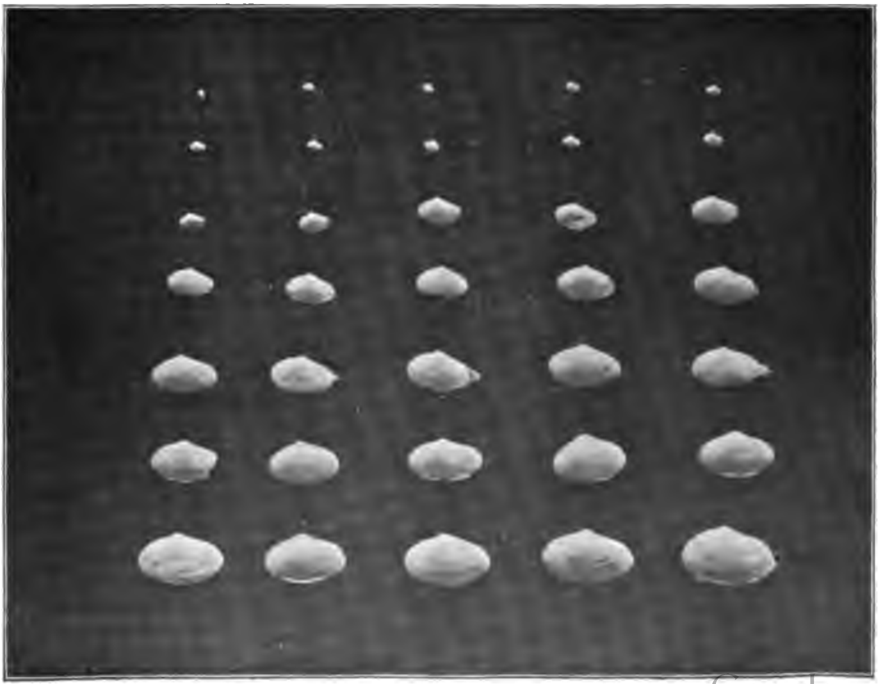

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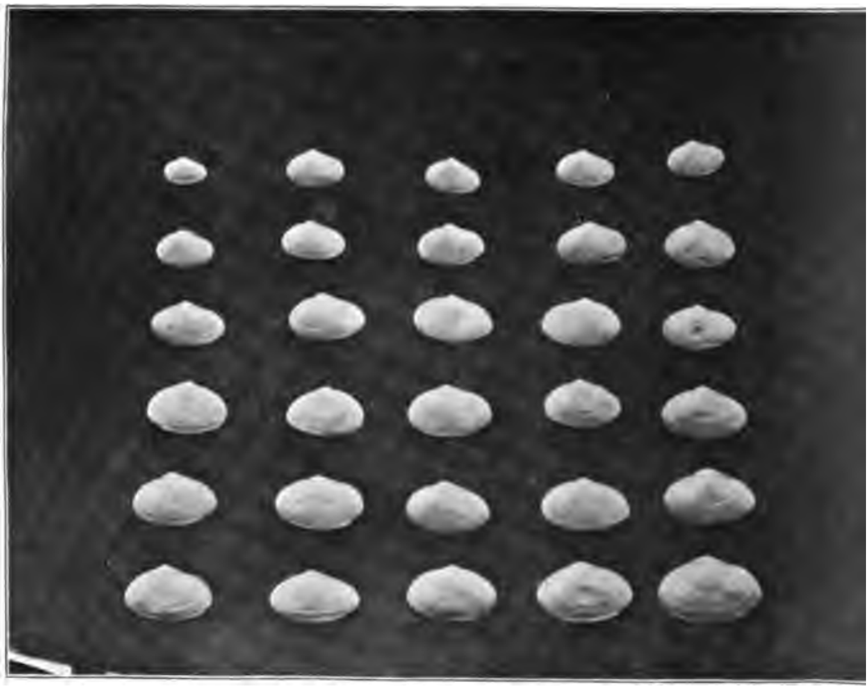

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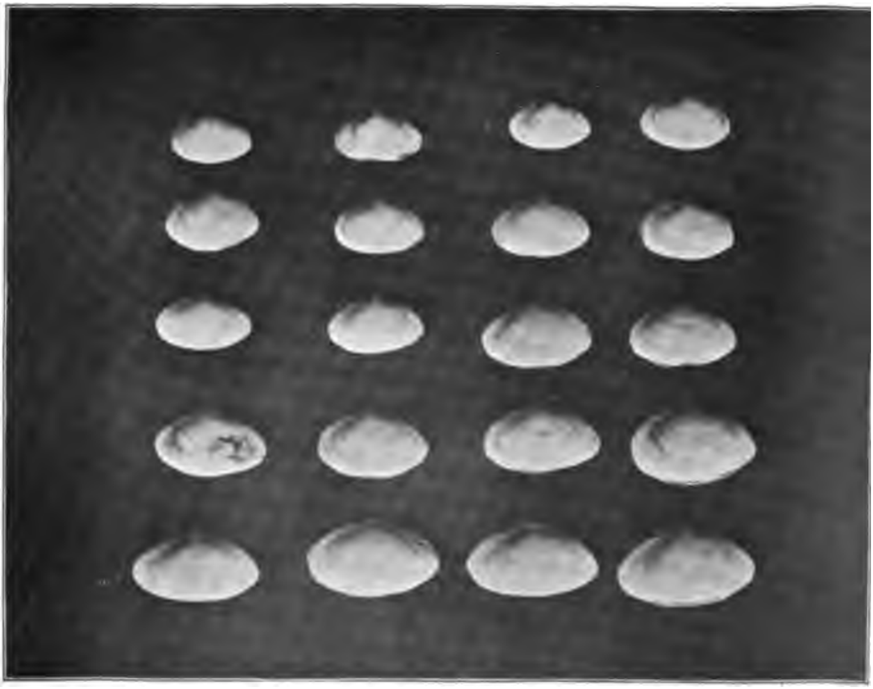

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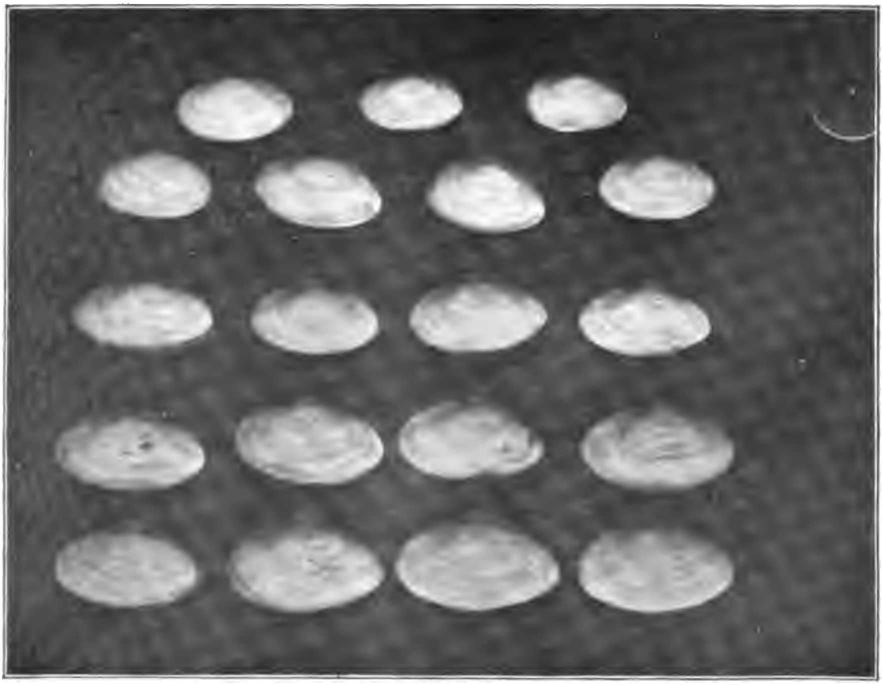

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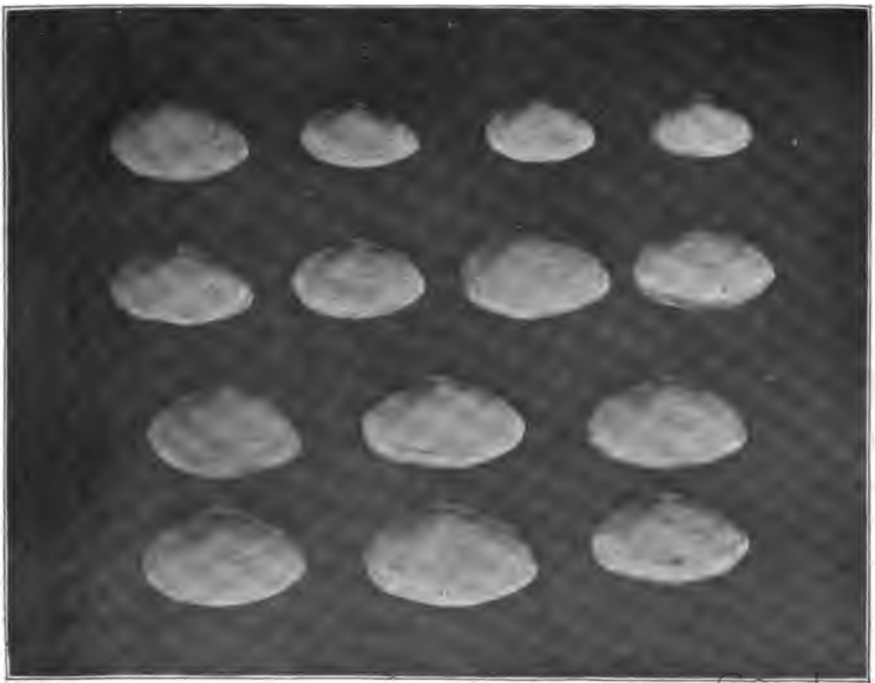

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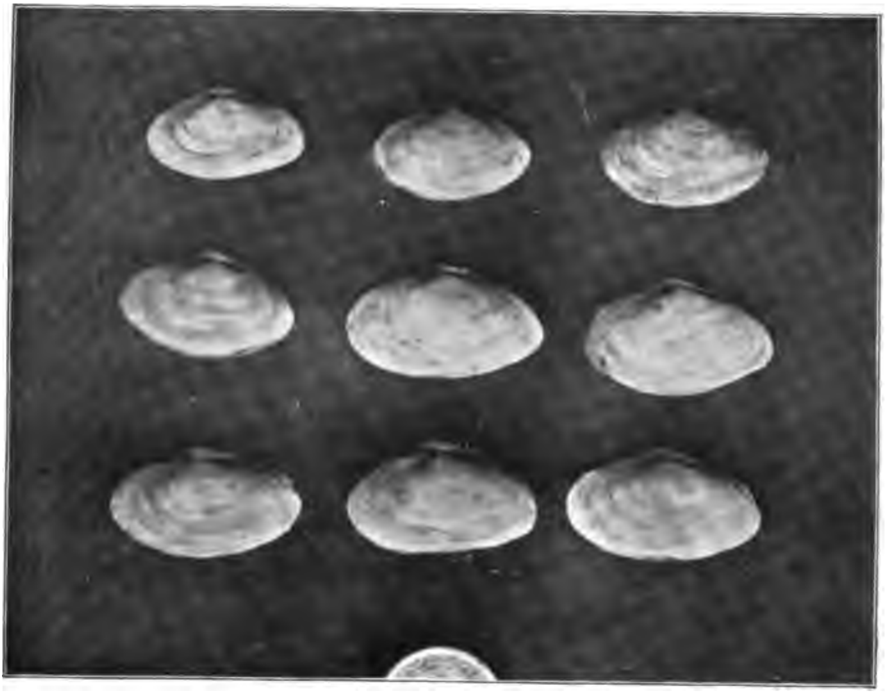

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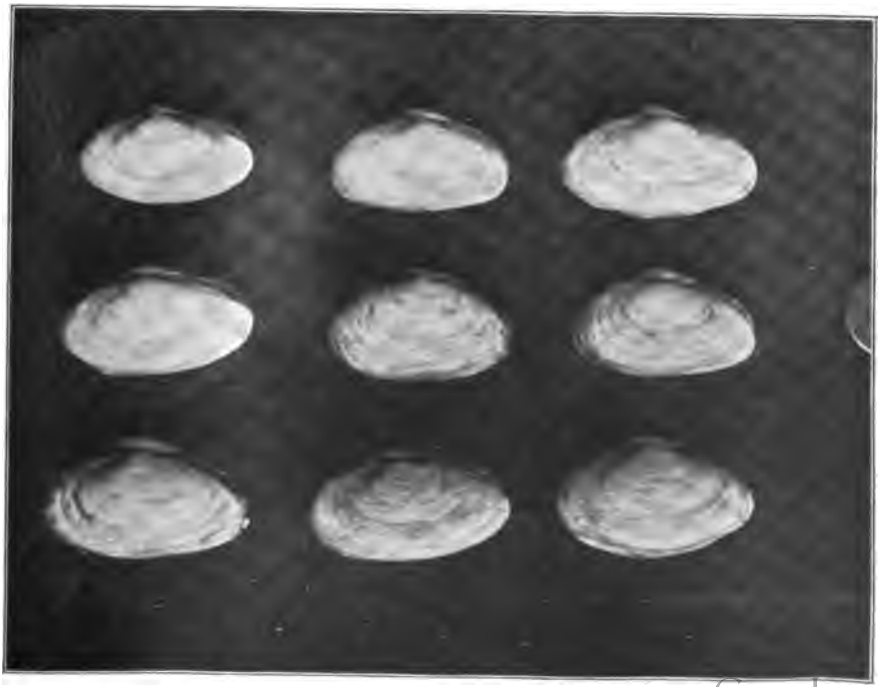

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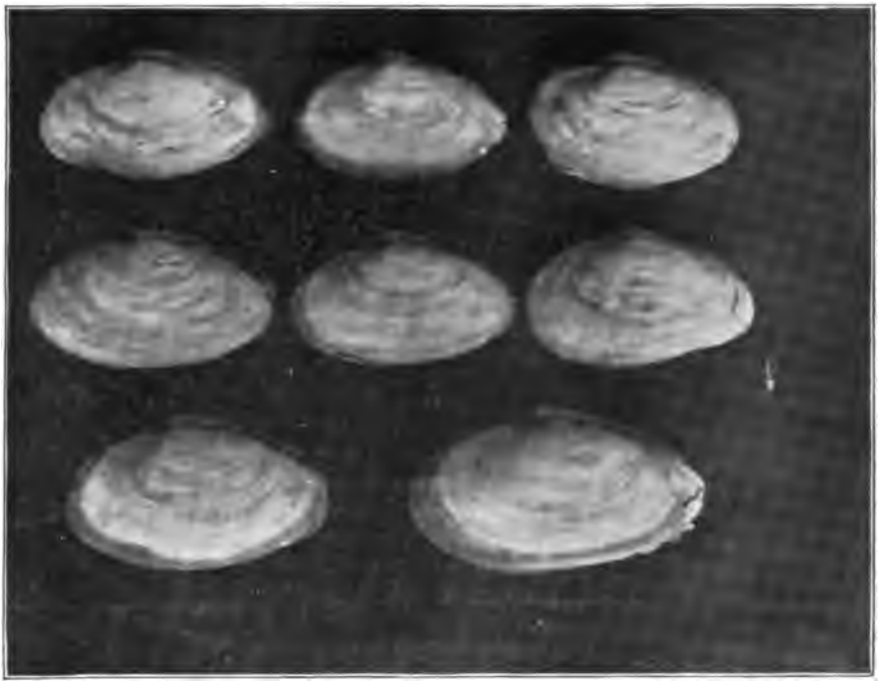

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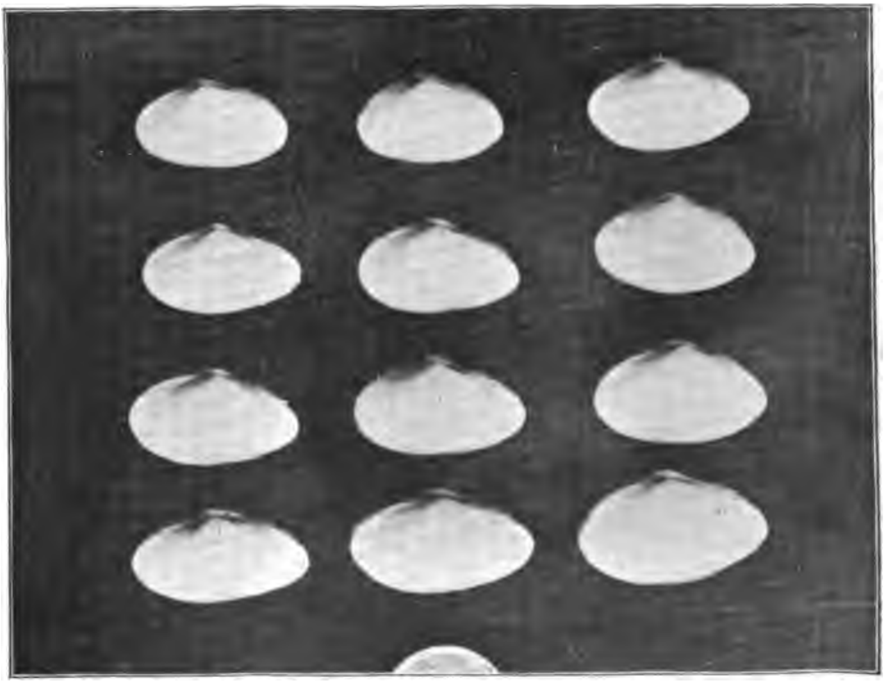

FIG. 15.

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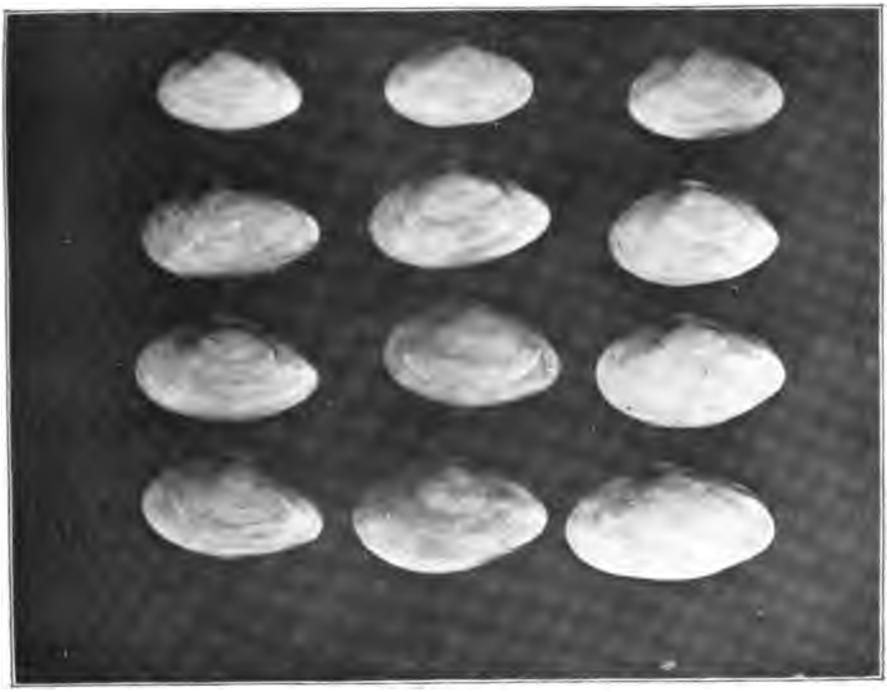

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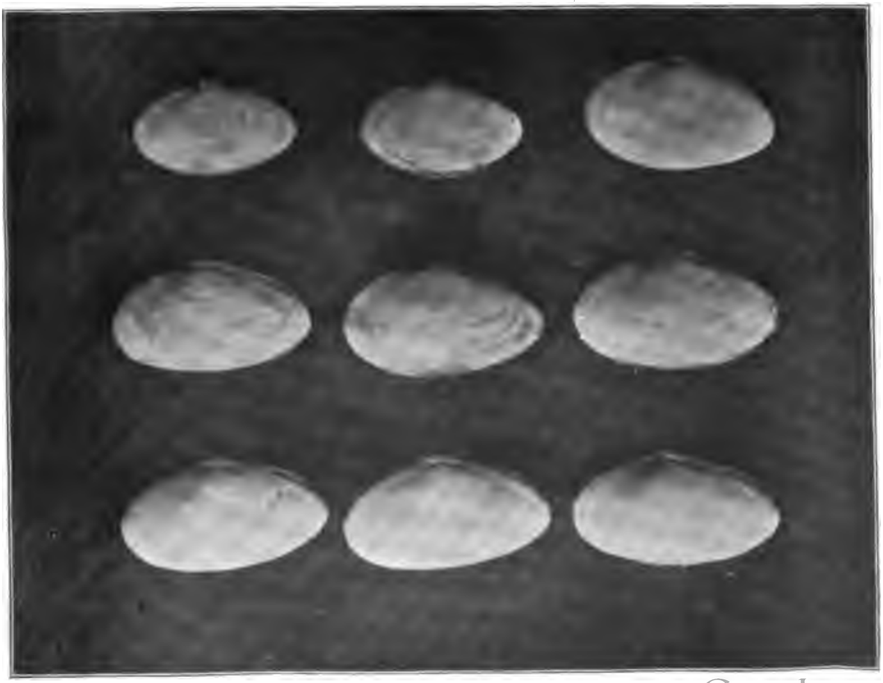

FIG. 17.

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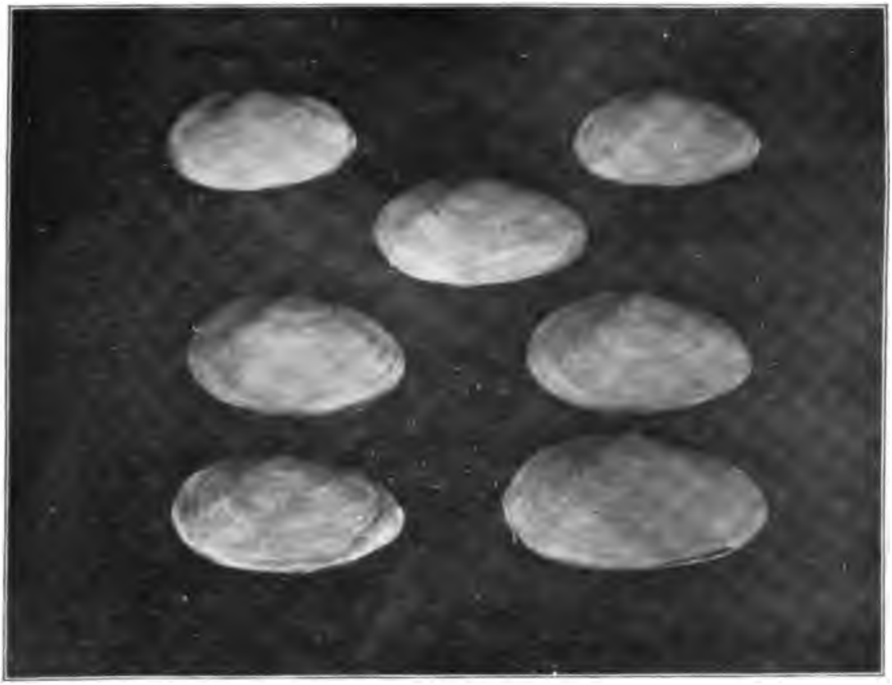

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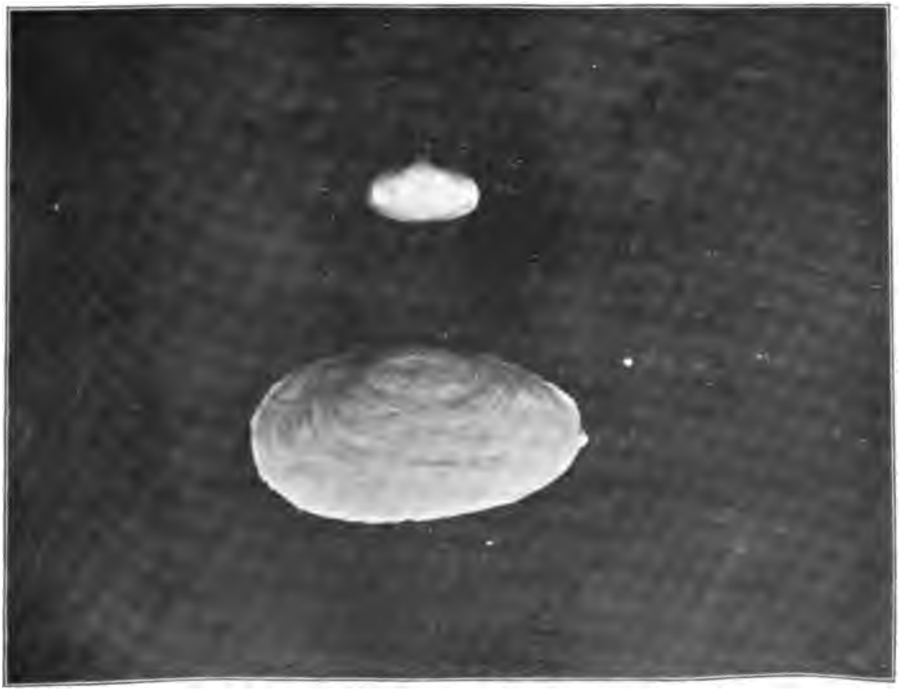

FIG. 19.

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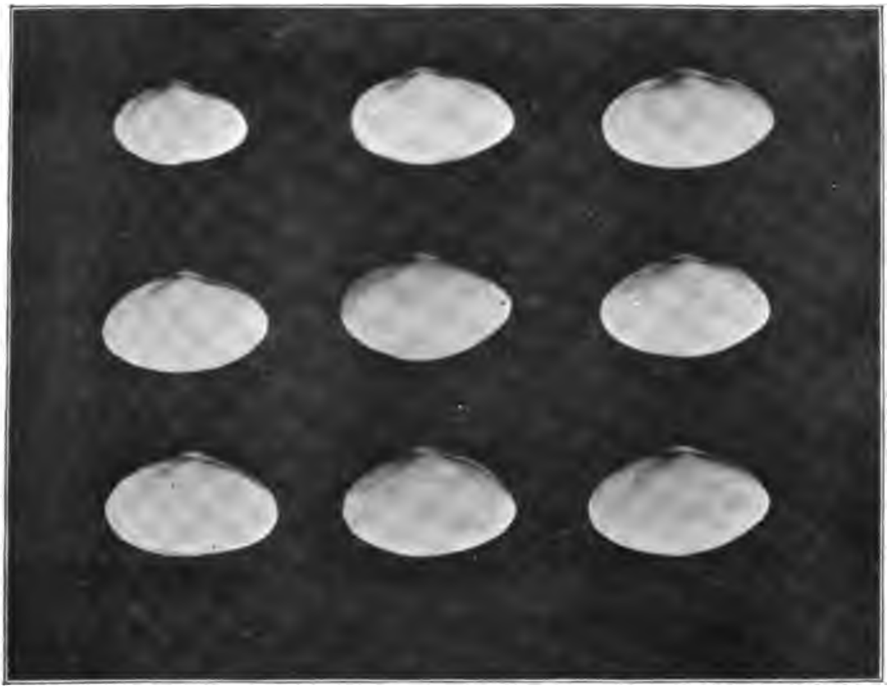

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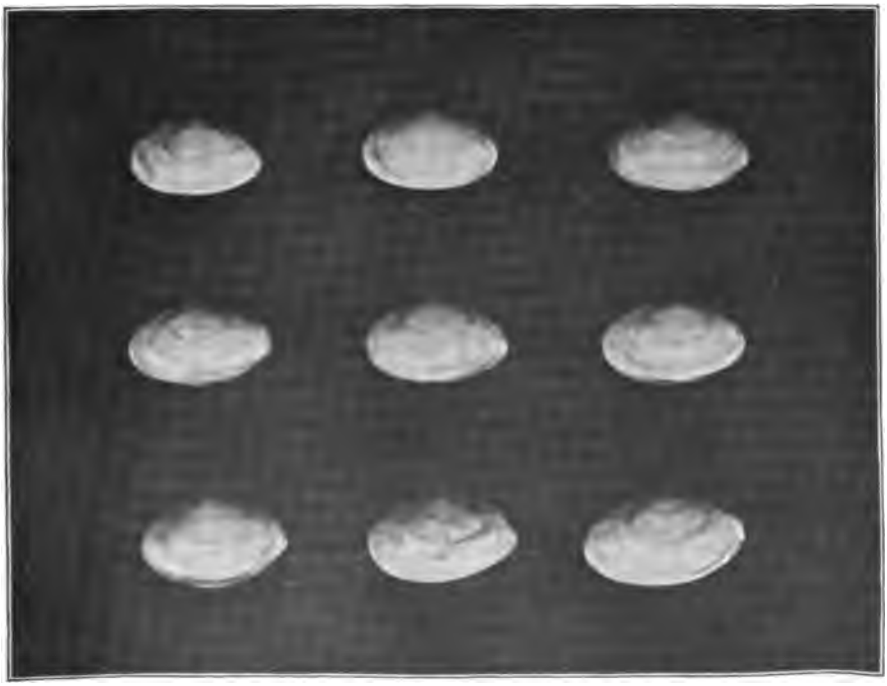

FIG. 21.

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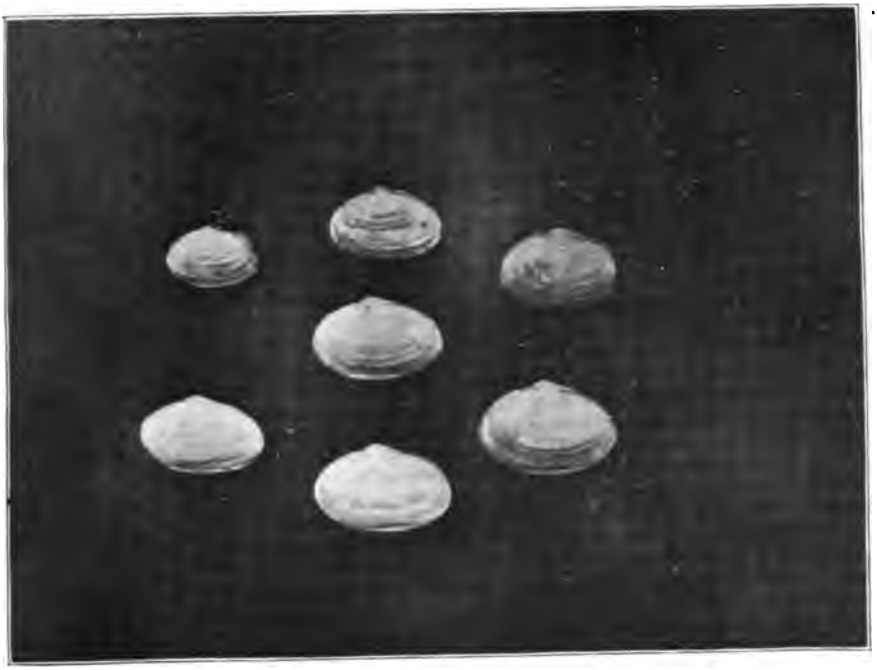

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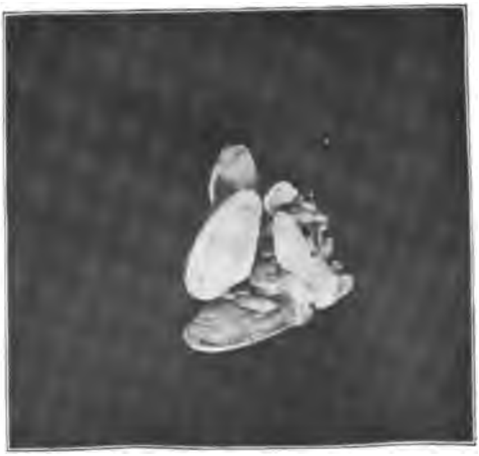
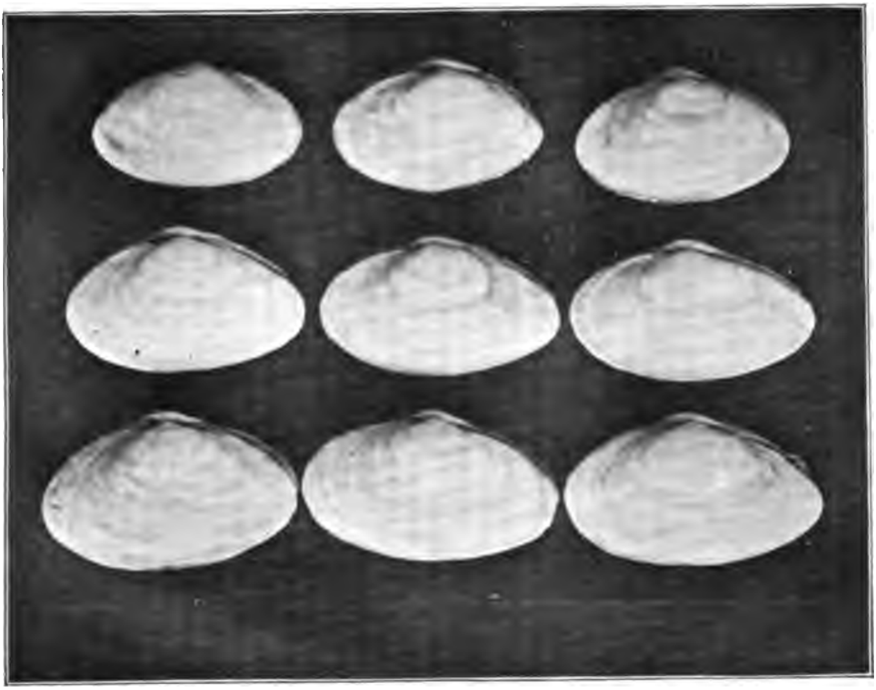


FIG. 23.

PLATE XI



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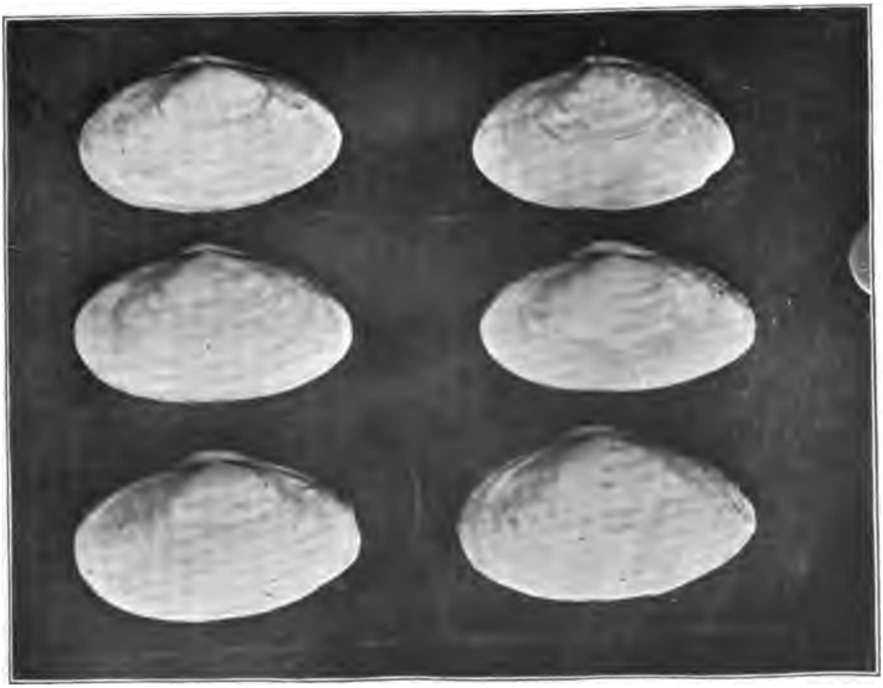

FIG. 25.

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